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S SERIES.

RAL HISTORY

ELEMENTS OF BOTANY.

PREPARED FOR THE USE OF

SCHOOLS AND COLLEGES,

BY

W. S. W. RUSCHENBERGER, M.D.

Surgeon in the U. S. Navy; Fellow of the College of Physicians; Hon.
Member of the Philadelphia Medical Society; Member of the
Academy of Natural Sciences of Philadelphia, &c. &c.

FROM THE TEXT OF

MILNE EDWARDS, AND ACHILLE COMTÉ,

PROFESSORS OF NATURAL HISTORY IN THE COLLEGES
OF HENRI IV, AND CHARLEMAGNE.

WITH PLATES.

PHILADELPHIA:

GRIGG & ELLIOT,

NO. 9 NORTH FOURTH STREET,

1846.



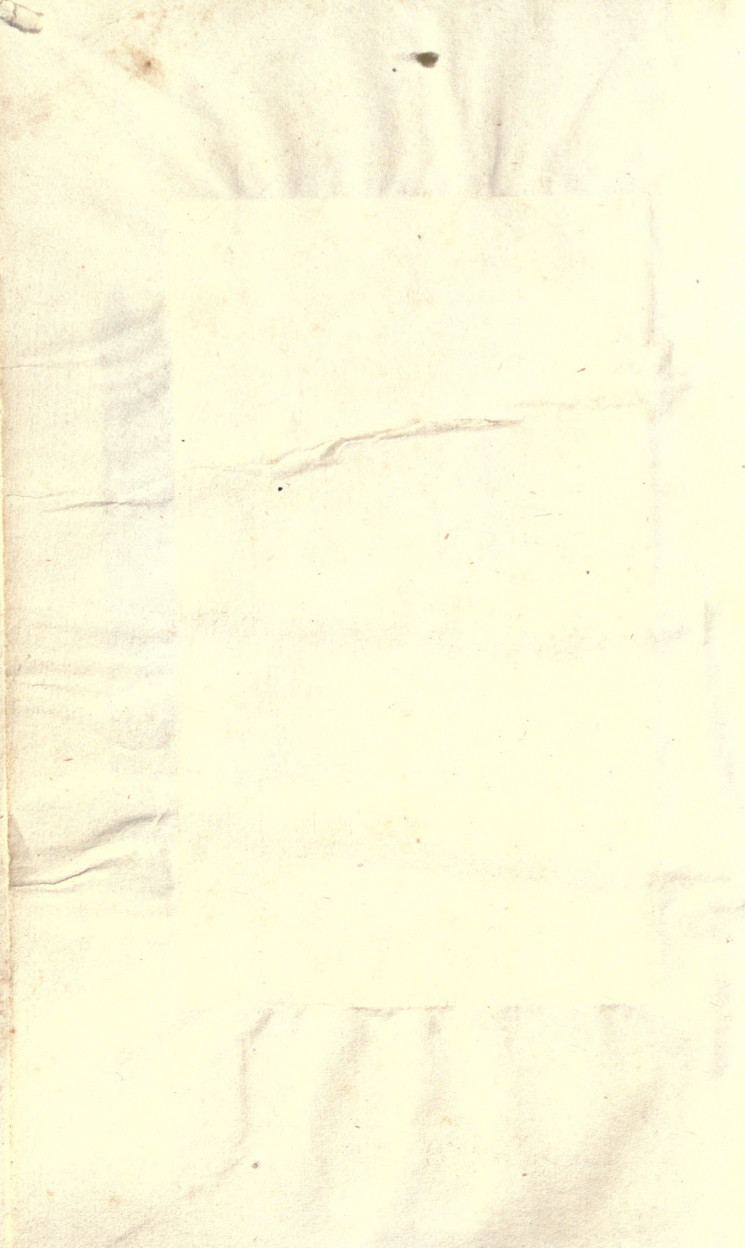
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These books have been introduced into the Public Schools of Pennsylvania and Ohio, and no doubt will, ere long, be introduced into all the public schools of our other States.

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This interesting series of books has already met with the most flattering reception ever extended to any work issued from the American press. Introduced into the Public Schools of Pennsylvania, and in nearly all the first class seminaries of learning in the United States.

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From "The Ladies' Companion, a Monthly Magazine." June, 1842.—New York. W. Snowden, 109, Fulton Street.

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"*Ornithology*.—This is evidently, like its predecessors, an excellent work of instruction; and has been, in all respects well got up by the publishers."—*Pennsylvanian*.

"A valuable little work, and is divided up and classified admirably. The glossary, giving the derivation of the names of birds, is of itself worth the price of the volume."—*New York Aurora*.

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"It is an excellent text-book of an interesting science, comprising much knowledge in a brief space, presented in a clear style and with lucid arrangement. Dr. Ruschenberger, who has already achieved a high character in the literary world, is acquiring additional claims by his exertions in the field of Natural Science."—*Spectator, Washington City*.

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"An excellent publication adapted to the youthful mind, and a great help to the more matured."—*Mercury*.

"The study of Natural History though generally neglected in schools, is of undoubted use: the present work contains a great amount of information within a small compass, and properly condenses it for the young mind."—*N. Y. Journal of Commerce*.

"*Ruschenberger's Series*.—The subjects are well treated, and from the exceeding cheapness, and admirable arrangement of these elementary works, they are well fitted for general use in public schools and academies."—*New York American*.

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"A well digested and carefully arranged abstract of the most interesting parts of Natural Science."—*Philadelphia Gazette*

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"Just such a work as is wanted for elementary instruction, in this pleasing branch of science."—*New York Evening Post*.

"We regard this series as eminently useful, supplying adequately the instruction in natural history necessary to a proper school education."—*North American*.

"It is an excellent little work for the purpose designed, written in a clear and familiar style, and will not fail to facilitate the studies of those who wish to make themselves acquainted with the subject."—*Saturday Courier*.

"Admirably adapted for elementary instruction."—*Saturday Chronicle*.

"We have great pleasure in recommending it as an excellent elementary manual on the subject."—*Medical Examiner*.

"*Ornithology*—This book is equal in merit to the first and second, and is a most valuable work. It is intended for the use of schools and academies, and we would call the attention of parents and others to the series of books to which this belongs, assuring them at the same time, that it will answer the purpose for which it is intended, better than any other work of the kind that we ever saw, or, in our opinion, that was ever published in this country. It is divided into questions and answers, contains an extensive and valuable Glossary, and is illustrated by eight Plates; and what is more the price is so very low that every person can afford to purchase it."—*New York New Era*.

RECOMMENDATORY NOTICES.

it has been justly observed, that "the double effect of the study of Natural History is to impart certainty to the mind, and religion to the heart," and the christian no less than the man of science, must rejoice in every effort to throw more widely open the sublime and boundless field which it presents. This is the design of Dr. Ruschenberger, in a series of First Books of Natural History, which he is preparing for the use of schools and colleges.—*Banner of the Cross.*

The series have met a demand and sale in France almost unparalleled, and the words are well adapted, not only for schools, but for popular reading and instruction. This work is from the French of Edwards and Comte, and has received the warm commendation of many of the best physicians and scholars in this country.—*N. Y. Eve. Tatler.*

It is highly commended by the very best authorities.—*N. Y. Tribune.*

This book is highly commended by competent judges, and we therefore give our solemn opinion that it is an excellent work.—*Boston Daily Times.*

A small, but very valuable work.—*Boston Evening Transcript.*

We have examined this new book for schools and colleges, with peculiar gratification. The style is succinct and clear, and the subject illustrated by appropriate drawings. We should be glad to see this work introduced into all the schools. It teaches knowledge the most important, which has been, however, strangely overlooked in our school and college system. It is a book which should not be confined to seminaries alone. It may be used with advantage by all individuals in society. We repeat, it is in all respects a most excellent work, and we hope will receive the attention and patronage it merits.—*Brooklyn Evening Star.*

A valuable work; we have read it with profit.—*N. Y. Mercury.*

We are highly pleased with this work. For elementary instruction in families, schools, and colleges, it is decidedly superior to any thing of the kind we have seen. It gives much valuable information in a very small space, and in style it is generally free from obtruse technicalities. It has already received the highest recommendations from a large number of professional men in different parts of the country; and it must have, we think, a general circulation. It gives that kind of knowledge which should be diffused among the mass of the people, and it must and will be patronised as far as its merits are known.—*Zion's Watchman.*

This is a fine little book, containing the elements of much useful learning, illustrated by anatomical plates of the human figure, its organs and their functions. It is a highly useful work to the student—indeed to every citizen it shows how fearfully and wonderfully we are made, and what slight causes may derange and utterly destroy the complicated machine.—*The Olive Branch*

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As far as we are competent to determine, it may safely be welcomed as an important addition to the means of elementary instruction in natural science.—*The Friend.*

We recommend it as a highly instructive publication.—*N. Y. Times and Eve. Star.*

This is a most valuable work, by Dr. Ruschenberger, and most admirably are the plates, representing all the different parts of the body, done. It is cheap, and every parent should place one in the hands of their children.—*N. Y. Herald.*

We have examined this little volume with much pleasure, and think it admirably adapted to the purpose for which it is intended. Animal Mechanism, as a study, has generally been neglected, except by the few, whose profession requires a knowledge of it, and who have time to spare in acquiring that knowledge. A prominent cause of the neglect of this useful and interesting science by the general student, is, the want of a suitable treatise upon the subject, those extant being too voluminous, technical, and expensive for general use. The little work before us is happily calculated to supply this want. It will, we think, be introduced into our schools and colleges as a textbook, but its circulation ought not to be confined there. Every private library should be considered incomplete without it.—*N. Y. Mechanic.*

It seems to us to be well suited for the object for which it is designed, and it will doubtless be introduced into many of our elementary schools.—*The American Journal of the Medical Sciences.*

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"The information it contains is at once lucid, intelligible, and satisfactory; it forms an excellent text-book for classes in schools, and cannot fail to infuse into the young mind a knowledge and love of Natural History. It is concise and comprehensive, and must if adopted in seminaries of learning be exceedingly useful in inculcating a correct knowledge of the elements of Zoology. The plan is excellent, and must be found eminently useful."—*Alexandria Gazette*.

"It is one of the most valuable works of the kind we have ever read.—Such are the books we like to see disseminated among the people."—*New Orleans American*.

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"We do not know a more useful set than this promises to be:—and IS."—*New York Aurora*.

"We hesitate not to say that it is a valuable work, and fully entitled to the high encomiums bestowed upon it; taken as a whole the work may be justly regarded as invaluable to schools."—*New York Standard*.

"It is a most valuable work, and one which we believe has no superior in our seminaries,—we know of nothing equal to it. It is very flatteringly recommended by the most distinguished men in France and in the United States, and deserves it."—*New York Courier and Enquirer*.

Ruschenberger's Second-Book of Natural History.—"This is another of those useful volumes, which Dr. Ruschenberger is so beneficially editing. His former volume has already been received into some of our public schools, and we hope both it and the present may find their way into all."—*American Medical Intelligencer*.

The present work, is in our opinion quite a desideratum, and abounds with information of the most useful and, at the same time, most necessary character, every parent should place it in the hands of his children, and no public instructor should neglect to give it a place in his academy.—*Philadelphia Spirit of the Times*.

RECOMMENDATORY NOTICES.

ORNITHOLOGY.—This is No 3, and like its predecessors is excellent. These are the most valuable additions of the day to our stock of School-Books. The avidity with which they have been seized upon is unprecedented. Though the first vol. was published for the first time only a few months ago, it has already gone into the fifth edition; the second is following close upon its heels; and the third promises to be even more popular than either of the other two. These books have been adopted by the "Royal Council of Public Instruction" for the use of Schools throughout France. They are recommended and have been adopted by some of the most eminent teachers in the United States.—*Southern Lit. Mes.*

The present book conveys a large amount of useful and pleasing information on Ornithology. The structure, functions, and habits of Birds, are classified and grouped in such a manner as to gratify the student of Natural History, and at the same time to aid the tyro in remembering the peculiarities of individual birds, and their various points of resemblances to others of their family.—*Bulletin of Medical Science.*

The Third Book of Natural History is worthy of being placed alongside the first and second. Of these we have already spoken; and we may now, we presume, congratulate Dr. Ruschenberger and the publishers, that sufficient encouragement has been received to induce them to continue their interesting and instructive series.—*American Medical Intelligencer.*

The series of books of which this forms a part has been highly and justly commended by the ablest judges, as furnishing rare facilities in the acquisition of branches of knowledge, but too much neglected in our schools. We have examined the volumes with much care, and we find them well deserving all the praise bestowed on them.—*Gody's Lady's Book.*

DR. RUSCHENBERGER'S series of books on Natural History are among the most valuable and useful works for the use of schools that have ever been published. The text is that of two distinguished French Naturalists, Milne Edwards and Achille Comte—translated and prepared for the use of schools and colleges by Dr. Ruschenberger, who deserves great credit for thus devoting his leisure to so useful an object. A knowledge of Natural History is not only valuable, but deeply interesting, and no one's education can, with such facilities as are now offered, be considered complete without it. Simple and comprehensive as the elements of this science have been made by the French professors and Dr. R., and adopted as they should be, in schools and colleges, it would be inexcusable in any youth to be ignorant of these elements, and having acquired them he will find it equally easy and pleasant to enlarge his knowledge by consulting more extended works, and devoting his attention to the study of the various branches of this interesting science. The present book on Ornithology is upon the same plan and possesses the same merit as those that have preceded it, and which have been received with deserved commendation. It is brief and comprehensive, but sufficiently full to give the student a thorough knowledge of the elements of Ornithology. It contains also a Glossary of the terms used in this branch of Natural History, and a number of wood cuts illustrative of the matter contained in the body of the work.—*Washington National Intelligencer*

Precisely the work to place in the hands of young people.—*Madisonian.*

"We have much pleasure in commending this series of works—the third of which now before us, is on Ornithology. It will be found useful in the school-room, or the private study."—*U. S. Gazette.*

RECOMMENDATORY NOTICES.

From the Carolinian, Fayetteville, N. C.

These books are the *first books*, or *elements* of the different studies of which they treat; calculated to convey the ideas without that labour of thought which might otherwise be attendant upon the commencement of the study. The great difficulty with the mind is to get a clear conception or understanding of first principles or rudiments of a study;—these once obtained, and the whole course is clear and smooth. These books of Grigg & Elliot, we think, so far as we are capable of judging, are admirably calculated to this end of simplifying, what to the young learner would appear abstruse. They are for sale at Mr. Hardie's Book Store, on Hay Street.

From the Daily Herald, New Haven, Conn.

They are published by Messrs. Grigg & Elliot, of Philadelphia, and are for sale in this city by Messrs. A. H. Malthy and S. Babcock. As elementary works they can hardly fail to be found useful in the study of the various branches of science which they embrace, and are at least worthy of the candid examination of all Teachers and Proprietors of Schools, Academies and Colleges, to whom the publishers' notice is particularly addressed. Questions, Glossaries, &c., are appended, to give all the necessary facilities to the student and the teacher.

From the Morning Courier, New Haven, Conn.

From a cursory examination of the work, and the consideration of the importance of a knowledge of the history of the various subjects treated of, as well as from the numerous testimonials which accompany the work—we are inclined to the belief that it is one of much merit, and worthy the attention of both teachers and learners.

OPINION OF JOHN FROST, A. M.,

Professor of Belles Lettres in the High School of Philadelphia.

Dear Sir,—I am delighted with your little book. It will form a very important addition to the means of elementary instruction in natural science. The subjects which it embraces form a part of our course of instruction in the Central High School of this city, and we consider this branch among the most important means of developing the powers, storing the minds and forming the habits of our students. I shall do my utmost to bring your book into general use; because I am greatly pleased with your plan, and I think it will do much towards directing the public attention to that much neglected, but important branch of science—the natural history of man.

Very truly and respectfully yours,

TO DR. RUSCHENBERGER.

JOHN FROST.

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*To Teachers, Principals and Controllers of Schools, Academies and Colleges, throughout the United States.*

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Messrs. Grigg & Elliot :

LEE'S PORT, BERKS Co., AUG. 25, 1845.

GENTLEMEN,—Accept my thanks for the series of Readers you were so kind as to send me by my friend Dr. Darrah, when he was last in the city. I consider them decidedly the best School Readers I have met with. I have introduced them into the school at this place, and find them fully to answer my expectations. I have also introduced Grimshaw's History of the United States, another of your valuable School publications. I am very much pleased with Dr. Ruschenberger's works on Anatomy and Botany, which you kindly sent me. They appear to be just the works needed to bring the subject of Natural History within the compass of our Common Schools; and I intend, during the coming winter, to make an effort to introduce the subject into the school here; and for this purpose, I would like to possess the whole series of eight uniform volumes, which I have requested Dr. Darrah to procure for me.

Very respectfully,

H. C. BAKER,

*Principal Lee's Port Seminary.*

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*From the Whig Courier, Pulaski, Tenn.*

SCHOOL BOOKS.—We have received, by the hands of Messrs. Martin & Topp, of Messrs. Grigg & Elliot, Philadelphia, a copy of their "New Series of Common School Readers." As this series has been so often recommended to Teachers, School Committees and Parents, by the press, and so far as we are able to judge, justly, properly and worthily too, we feel no hesitancy in endorsing the following—from JOHN FROST, LL.D., Professor of Belles Letters in the Philadelphia High School:—

"I have examined your Readers with great pleasure, and have no hesitation in recommending them to the special favour of Parents, Teachers, and School Committees; they are calculated to be eminently interesting to the young, from the happy style of narration, dialogue and description, which pervades the series; but their chief excellence is their UNEXCEPTIONABLE MORAL TENDENCY. It would hardly be too much to say, they comprise a complete system of moral instruction, and in this point of view, I know of no books used in Common Schools which are preferable to them."

*From the Philadelphia Gazette.*

These are four little volumes to be used in schools, as reading books. They afford progressive exercises for the learner in the art of reading, at the same time that they convey a large amount of useful knowledge, particularly adapted to the wants of the rising generation of this country. This is a most important part of elementary instruction, to which less than due attention has been paid. We cordially endorse the commendation of the series given by Professor Frost, of the High School.

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*From the Alabama Reporter, Talladega.*

Messrs. Grigg & Elliot, of Philadelphia, have kindly sent us a copy of their series of Common School Readers, numbered 1, 2, 3 and 4. We have examined them carefully and find them first rate books for children just commencing to read, number 2 being for those a little further advanced, and number 3 for those still further. Their moral tendency is unexceptionable, and withal they amuse the learner, while they convey instruction in the rudiments of the most valuable arts and sciences, and history. We take great pleasure in recommending them with confidence to parents, teachers, and all those who have the care of the young of either sex. The books are for sale by Messrs. John Hardie & Co. of Mardisville.

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*From the Philadelphia Enquirer & Courier.*

Messrs. Grigg & Elliot, No. 9 north Fourth street, have just published Nos. 1, 2, 3 and 4 of their new series of Common School Readers. These are among the best works of the kind that are issued in our country. Professor Frost, of the High School, recommends them to the especial attention of parents, teachers and school committees, and says they are calculated to be eminently interesting to the young, from the happy style of narration, dialogue and description, which pervades the series; but their chief excellence is their unexceptionable moral tendency. They are issued in a cheap and substantial form, and are sold at very low prices.

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*From the North American.*

Messrs. Grigg & Elliot have issued four books, designed as progressive exercises in reading, for the use of learners. The object of publications of this kind is an important one, and, until of late years, it has not sufficiently engaged the attention of those who labour especially in the cause of juvenile instruction. The plan of these books is to afford not only exercises in reading as an art, but to convey at the same time, peculiarly useful knowledge for the rising generation of this country. We cordially endorse the commendation of the series given by Professor Frost, of the High School.

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*From the Democratic Recorder, Fredericksburg, Va.*

We are indebted to the publishers, Messrs. Grigg & Elliot, Philadelphia, for a new series of reading books for schools, just issued by them. We have examined them with care, and recommend them with much pleasure. The introductory les-

sons are well calculated to induce a fondness for reading, and to imprint upon the youthful mind the soundest moral impressions. One great fault of some other reading books, is completely remedied in this:—the transition from one book to the other is easy and natural. The scholar is not presumed to have doubled his knowledge when his text book is doubled in size. The embellishments (a thing not to be neglected when catering for juveniles) are remarkably good. To be had at White's.

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*From the Washington (Pa.) Reporter.*

We are indebted, through Mr. H. M. Koontz & Co., to the firm of Grigg & Elliot, extensive book publishers of Philadelphia, for a complete "series of Common School Readers," comprised in 4 volumes. We have given them a cursory perusal, and also handed them to an esteemed female teacher, an admirable judge in such matters, who unites with us in pronouncing them most meritorious.

The series is handsomely gotten up, being interspersed with appropriate engravings. The arrangement is excellent, and the matter unexceptionable in its moral tone and tendency.

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*From the Reading Gazette.*

Messrs. Grigg & Elliot, of Philadelphia, have favoured us with copies of their new series of Common School Readers, selected from some of the best works of their kind, and prepared for the gradual instruction of scholars, which would be found of great service if introduced into all our common schools.

The Reader, No. 1, is prepared specially for beginners, and contains pieces easily intelligible, instructive and interesting, illustrated with engravings, and treats of matters and in language such as any child can understand.

Reader, No. 2, is the old Pleasing Companion, a work which has, for some years, held a deserved esteem in school instruction. The selections it comprises, it is well known, are of the most pleasing kind; and instead of making reading a task, sufficiently interests the scholar to read and understand its fascinating instructions.

Reader, No. 3, is another work of reputation—and its admirable lessons of moral and religious instruction, have secured it a place in many schools. The object of the work—"to inculcate the necessity and duty of general, domestic and national economy and simplicity of manners," is one of interest to every patriot; and there certainly can be no better mode to perpetuate that object, than to instruct the rising generation in its principles.

An examination of the work will strictly satisfy, that if the end be not accomplished, it is no fault of the compiler.

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*From the Gallatin (Tenn.) Union.*

We acknowledge the receipt, from Messrs. Grigg & Elliot, Philadelphia, of four volumes of reading books for common schools.—From a cursory review of their contents we are well pleased with them, and would recommend them to be used in our schools.



*From the U. S. Gazette.*

Messrs. Grigg & Elliot have published a series of reading books for common schools, prepared with a special reference to the progression of scholars, each lesson referring to some subject of interest to the young, so that the pupil will have an interest in his lesson, and not read merely because "it is his turn now."

The compiler of the work has had a special eye to sound morals, to pure benevolence, and to the application for good of all his pieces, and hence his series commend themselves to high approval. We have some special acquaintance with the use of the works, and are glad to see that the first is a proper introduction to its successor; so that we may, and do, confidently recommend the series as eminently deserving a place in schools, as well from their moral tendency, as from the adaptation of the contents to the progression of the scholar in classes.

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*From the Olive Branch, Youngstown, Ohio.*

Grigg & Elliot, of Philadelphia, Pa., have published a new series of Common School Books, Nos. 1, 2, 3 and 4. They are, so far as our opinion is worth any thing, worthy of being adopted by an enlightened public; their chief excellence being the moral instructions communicated.

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Through the politeness of Andrew Gray, Esq., who has just returned from the city of Philadelphia, we have been presented with a copy of Grigg & Elliot's new series of Common School Readers, intended for the instruction of children, and upon a careful examination of them, we feel justified in saying that a better series of school books cannot be put into the hands of the rising generation.

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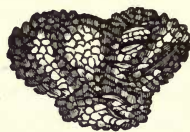
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BY

W. S. W. RUSCHENBERGER, M.D.

SURGEON IN THE U. S. NAVY; FELLOW OF THE COLLEGE OF PHYSICIANS; HON.  
MEMBER OF THE PHILADELPHIA MEDICAL SOCIETY; MEMBER OF THE  
ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA, ETC., ETC.

FROM THE TEXT OF

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PROFESSORS OF NATURAL HISTORY IN THE COLLEGES  
OF HENRI IV., AND CHARLEMAGNE.

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WITH PLATES.

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1846.



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## PREFACE.

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The SEVENTH in the Series of FIRST BOOKS OF NATURAL HISTORY, comprises the Elements of Botany.

This subject is deeply interesting, useful, and consequently popular, which may be readily inferred from the great number of books published on this branch of Natural Science. Whether the little volume now presented will find favour with the public, among the many that have been well received, time will show. It is brief, and I have attempted to make it clear to beginners. The explanations and etymologies of technical words are given as they occur, either in the text, or in foot notes, and in many, if not in all cases, the pronunciation of these words has been designated by accents. When it occurs, the Greek *omega* has been marked thus ( $\omega$ ), and *italics* have been substituted for Greek characters, because, it is presumed, many who may use this volume are unacquainted with the dead languages. An ample glossary has also been appended.

Besides the work of Messrs. Edwards and Comte, which forms the skeleton of this, I have freely consulted the writings of Lindley, Loudon, Smith, Gray, Reed, and others, and as freely appropriated whatever seemed useful to us in carrying out the design of forming an accurate, brief, and simple treatise on the Elements of Botany, suitable for beginners, whether young or old.

The numerous illustrations, engraved by Mr. G. Thomas (65 South Third Street, Philadelphia), have been well executed, and do credit to the artist.

The present edition has been carefully revised, and several new figures have been added; this little volume now contains one hundred and sixty-four illustrations.

W. S. W. R.

U. S. Naval Hospital, New York. }  
July, 1844.



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# ELEMENTS OF BOTANY:

## THE NATURAL HISTORY OF PLANTS.

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### LESSON I.

**BOTANY.**—*Definition of Plants—Structure of Plants—Nomenclature of Organs.*

1. Botany (formed from the Greek word *botané*, a plant) is that division of Natural History which treats of vegetables.

2. The science of Botany is divided into three branches: namely, the Anatomy of Plants, Vegetable Physiology, and Descriptive Botany, which last comprises the classification of plants and their especial history.

3. Botany, therefore, does not consist, as is commonly imagined by the ignorant, in merely “getting by heart” a great number of names of plants, and of being able to apply their names to the objects to which they belong; but in a knowledge of the plants themselves, of their organization, their growth, their manner of living, their properties, and the relations they bear to each other, as well as the characters by which they are distinguished from each other.

4. *Definition of Plants.*—Plants are beings organized for living; but they are not endowed, like animals, with the faculties of sensation and of performing voluntary motion.

5. Like animals, these beings are readily distinguished from inorganic bodies by their mode of structure, by their nutritive function, through the means of which their substance is renewed and augmented, by their origin, and by the limited duration of their existence.

6. They differ from animals not only in being destitute of the functions of relation, but also in many other respects. Almost all vegetables live fixed in the soil; they absorb, from without, nutritive matters which they assimilate, without previously di-

- 
1. What is Botany?
  2. How is the science of Botany divided?
  3. What is to be learned by studying Botany?
  4. What are plants?
  5. How are plants distinguished from inorganic bodies?
  6. How do plants differ from animals?



gesting them, and they have nothing which resembles a stomach ; by the act of respiration, they possess themselves of the carbonic acid of the air, and exhale the oxygen.

7. We have said that vegetables are destitute of the faculty of sensation, and the faculty of performing voluntary motion : this is very evident in an immense majority of instances ; but there are some plants which, at first sight, seem to form an exception to this rule. For example, the branches and leaves of all plants are directed to that side from which they receive the light and air. Certain plants on the approach of night, or the morning dawn, close their leaves or flowers : and there are some that contract themselves in this manner when they are touched by any foreign body. The small shrub called the *Sensitive Plant* exhibits this phenomenon in a very remarkable manner : and a plant of certain Carolina marshes, Venus's Fly-trap, — *Dionæa muscipula* (*fig. 1*)—performs these motions most singularly ; the leaves, which are formed of two lobes, are so irritable that they close on the slightest touch ; when an insect alights upon the internal face of one of them, the two lobes immediately approximate each other, and the animal, caught upon the thorns with which these lobes are armed, dies in this species of natural snare. The Sundew, — *Drosera*, — the white flowers of which often deck the pools in France, are somewhat analogous, for the hairs which fringe their broad round leaves, lie down the moment they are irritated by the contact of a foreign body.



*Fig. 1.*—VENUS'S FLY-TRAP.

8. But these phenomena differ essentially from the voluntary movements of animals ; there is no proof that the plants we have

7. Do plants feel ? Are they capable of voluntary motion ?

8. Is there any positive proof that vegetables feel, or move of their own will ?

just mentioned experience sensations, nor that the motions performed by them are directed by will: sometimes these movements result from the action of heat or humidity upon certain parts of their tissues, and at other times they can only be compared to the automatic movements, which are readily brought about by means of electricity or galvanism, in animals that have been recently killed and deprived of the functions of relation.

### *Of the Structure of Plants in General.*

9. Although plants differ very widely from each other in their external forms, they closely resemble each other in the materials of which their organs are composed: if we examine the internal structure of plants by the aid of a microscope, we find they consist entirely of cellular tissue alone, or at most of cellular tissue united to vessels.

10. Plants that are composed entirely of cellular tissue are called *cellular plants*, and those formed of cellular tissue and vessels are named *vascular plants*.

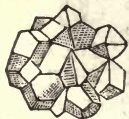
### *Of Cellular Tissue.*

11. The cellular or utricular tissue of vegetables consists of a multitude of vesicles (minute cells) filled with a liquid or other substance; sometimes these little bladders are rounded and loosely attached to each other (*fig. 2*); but in general they are so strongly pressed against each other that they are flattened at the points where



*Fig. 2.*  
VESICLES.

they touch, and take the form of polygons (from the Greek, *polus*, many, and *gone*, sides, *figs. 3 and 6, g, c*); at the same time their union becomes so intimate that it is difficult to separate them, and the cells formed by their cavities seem to be separated only by simple partitions, as cavities would be if hollowed out of a continuous or solid mass, like the cells of a honey-comb, for example.



*Fig. 3.*  
VESICLES.

*Explanation of Fig. 2.*—Utricle or cells of the cellular tissue, which have preserved their primitive form, magnified.

*Explanation of Fig. 3.*—The same cells which have become poly'gonal in consequence of pressing against each other.

9. Do plants differ from each other in their internal structure as much as they do in their external form?

10. What are cellular plants? What are vascular plants?

11. Of what does the cellular tissue of plants consist? Are all cells of the same form?

12. The form of these cells varies very much: sometimes they are spherical or octa'gonal, at other times flat or very much elongated, and tapered at their extremities like spindles (*fig. 4*); in the latter case they are often designated under the name of *clostres*. Their surface frequently presents rays or points which resemble pores, but in reality these vesicles are completely closed, and are without openings or orifices; their parietes are naturally transparent, and almost colourless; but ordinarily these cells contain granules which are deposited on their internal surface, and, when these corpuscles (little bodies) are green, brown, red, &c., their parietes appear to be coloured in the same manner. The colour of different parts of plants depends upon this circumstance.



Fig. 4.  
VESICLES.

13. The cellulæ (little cells) of the cellular tissue often have between them empty spaces of more or less extent, called *inter-cellular meatus*, or *inter-cellular pores*, or *passages*: these cavities, which are of irregular form, are very important, as we shall see in the sequel.

### Of Vessels.

14. The vessels of plants are generally cylindrical tubes, which sometimes resemble excessively elongated cells (*fig. 5*). They differ very much in their structure, and they are divided into tracheæ, false tracheæ, punctuated or dotted vessels, moniliform vessels, reticular vessels, mixed vessels and proper vessels.



Fig. 5.  
VESSEL.

15. *Tracheæ*. We give the name of tracheæ to tubes, which closely resemble the tracheæ of insects, for, like them, they are formed of a thread spirally folded (*fig. 6*). This thread, which is silvery white, is very elastic and easily unrolled; and if we carefully break a leaf of a rose tree, or dog-wood, for example, we

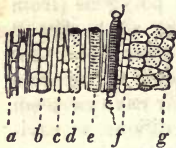


Fig. 6.—TRACHEÆ.

*Explanation of Fig. 4.*—Clostres or fusiform cells of wood, magnified.

*Explanation of Fig. 5.*—A punctuated or dotted vessel, magnified.

*Explanation of Fig. 6.*—Vertical section of a stem, showing the cellular tissue of which the epidermis is composed (*a*); the cellular tissue of the bark (*b*); the clostres of the fibre of the wood (*c*); a punctuated vessel (*d*); a rayed vessel (*e*); a tracheæ (*f*); and soft cellular tissue (*g*).

12. What are clostres?

13. What are inter-cellular passages?

14. How are the vessels of plants divided?

15. What are tracheæ? (Tracheæ, the plural of trachea,—pronounced *tra'-ke-ah*—wind-pipe.)



find the two fragments united to each other by filaments, similar to spider's web, which are, in fact, the unrolled tracheæ. Sometimes, instead of being formed of a single spiral thread, these vessels are composed of two or three parallel threads rolled together. Their length is, in general, very considerable, and it seems that they terminate in a point at each extremity; they do not branch or ramify like blood-vessels in animals, and ordinarily they are united in bundles.

16. The *false tracheæ*, which are also called *annular*, or *radiated vessels*, are unramified tubes, marked by transverse parallel rays (fig. 6, e). When the rays are very close together, these vessels resemble tracheæ very much, but they are not elastic and cannot be unrolled.

17. The *punctuated* or *dotted vessels* (fig. 5) are cylindrical tubes like the preceding, but their parietes are dotted with small opaque points arranged in parallel or oblique series. They were formerly called *porous vessels*, because it was believed that these dots were holes, but we are now assured that they are not pores.

18. The *reticular vessels* are cylindrical tubes, the surface of which being covered by oblong transverse spots, gives them the appearance of a net.

19. The *mixed vessels* are tubes which at different points in their length seem to possess alternately the characters of the three kinds of vessels we have just mentioned.

20. The *moni'liform*, or *bead-like vessels*, are punctuated tubes which ramify, and are contracted or strangulated at different points (fig. 7). Many botanists suppose they consist of series of cells attached to each other, end to end.



Fig. 7.  
VESSELS.

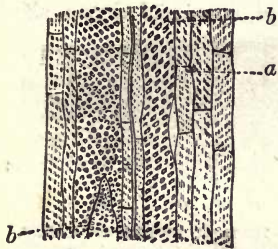


Fig. 8.—VESSELS.

21. The *proper vessels* (fig. 8,

*Explanation of Fig. 7.*—Moni'liform (bead-like) vessels, magnified.

*Explanation of Fig. 8.*—Vertical section of a stem, showing cellular tissue with elongated cells (a); and the reservoirs of the peculiar or proper juices (b, b).

16. What are false tra'chèæ?

17. What are punctuated or dotted vessels?

18. What are reticular vessels? (Reticular; from the Latin, *rete*, a net.)

19. What are mixed vessels?

20. What is meant by moniliform vessels? (Moni'liform, from the Latin, *monile*, a necklace, a string of beads, and *forma*, form.)

21. What are proper vessels?

b) are cavities which are sometimes in the form of short blunt tubes, and sometimes they are elongated very much; they enclose the particular juices of the various species of plants.

22. Finally, the *vessels of the la'tex* are ramified canals, which may be considered as a sort of *proper vessels*; according to some botanists, they are lined by a proper membrane, but according to other observers, they have no lateral parietes, and are merely inter-cellular passages or *meatus*. (*La'tex* is a Latin word, signifying a peculiar fluid, which is usually turbid, and coloured red, white or yellow; often, however, colourless.)

### *Of the Compound Constituent Parts of Organs.*

23. The elementary parts of plants we have just mentioned constitute, either alone or by their union, the tissues and the different organs which, in their turn, concur in the formation of the various apparatuses constituting the body of these beings. Such are the fibres, the epidermis, the hairs, the glands, &c.

24. *Fibres*.—The fibres which are often found in the different parts of plants, but chiefly in the stems, are not composed of a peculiar tissue, but are formed of vessels united in bundles, intermingled with *clostres* or elongated cells. Among these vessels, we sometimes find tra'cheæ, but most of them are punctuated vessels. The filaments thus formed are arranged parallel to each other, and joined together by a more or less loose cellular tissue; it is therefore much easier to separate them lengthwise than transversely.

25. Epidermis (from the Greek *epi*, upon, and *derma*, skin). The epidermis or cuticle is a thin membrane which covers the external surface of plants; it is especially distinct in the young stems, the leaves and roots; it is composed of cellular tissue, the cells of which adhere more strongly to each other than to the subjacent parts, and for this reason

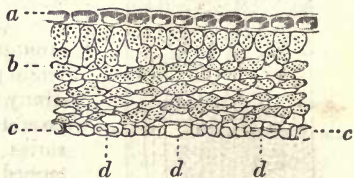


Fig. 9.—VERTICAL SECTION OF A LEAF.

*Explanation of Fig. 9.*—Vertical section of a leaf magnified;—a. the epidermis of the upper surface;—b. the paren'chyma formed of cellular tissue, in which we observe inter-cellular passages or *meatus*;—c, c. epidermis of the lower surface;—d, d, d. the stomata cut transversely.

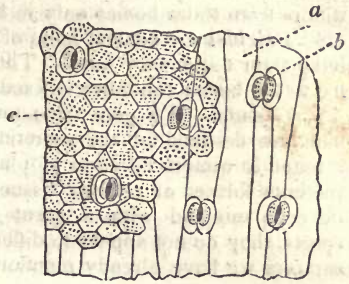
22. What are the latex vessels?

23. What elementary parts constitute the tissue of plants?

24. What are fibres?

25. What is meant by epidermis? What are sto'mata? Where are they found?

it is, in general, easily raised up (*fig. 9, a* and *c*): we often remark in it little openings called *sto'mata* (from the Greek, *stoma*, mouth), which are not visible without the assistance of a magnifying-glass (*fig. 10, b*); the edges of these pores are formed by two oval or globular cells filled with green globules, and their opening corresponds with the inter-cellular vacuities or *lacunæ* (*fig. 9, b*), the uses of which appear to be very important in the respiration of plants. No *sto'mata* are found upon the roots; many cellular plants, such as mushrooms and mosses, are altogether without them, and they are also wanting in certain plants that live in water.



*Fig. 10.*—HORIZONTAL SECTION OF A LEAF.

26. The hairs of plants are external appendages formed of elongated and projecting cells; sometimes they are simple, that is, composed of a single cell; sometimes they are partitioned, that is, formed of several cells arranged in a row, end to end, and at other times they are more or less branching; sometimes they lie upon glands, and serve as an excretory canal to the caustic juices secreted by these organs.

Hairs vary extremely in length, density, rigidity, and other particulars; on this account they have received the following names:

*Down*, or *pubescence*, when they form a short soft layer, which only partially covers the cuticle or epidermis.

*Hairiness* (*hirsutus*), when they are rather longer and more rigid.

*Pilosity* (*pilosus*), when they are long, soft, and erect.

*Villosity* (*villosus*), when they are very long, very soft, erect, and straight. *Crini* (*crinitus*) are this variety in excess.

*Velvet* (*velutinus*), when they are short, very dense and soft, but rather rigid, and forming a surface like velvet.

*Ciliae*,—eye-lashes (*ciliatus*),—when long, and forming a fringe to the margin, like an eye-lash.

*Bristles* (*setæ*—*setosus*), when short and stiff.

*Stings* (*stimuli*—*stimulans*), when stiff and pungent, giving out an acrid juice if touched, as in the nettle.

*Glandular hairs* (*pili capitati*), when they are tipped with a glandular exudation.

*Hooks* (*hami*, *unci*, *rostella*), when curved back at the point.

*Barbs* (*glochis*—*glochidatus*), if forked at the apex, both divisions of the fork being hooked.

*Explanation of Fig. 10.*—Horizontal section of a leaf, magnified:—*a.* epidermis;—*b.* stomata;—*c.* cellular tissue of the parenchyma.

26. What are hairs? Mention some of their varieties.



27. *SCURF* consists of thin flat membranous disks, with a ragged margin, formed of cellular tissue springing from the epidermis. It may be considered as a modification of hairs; for it differs from those bodies only in being more compound.

28. *Prickles* are conical hairs of large size, sharp pointed, and having their tissue very hard. They differ from thorns in being fixed to the bark; the thorn is fixed to the wood.

29. *Glands*. We give the name of glands to those organs which are destined for the secretion of particular liquids: they are found in almost all parts of plants; they are small cavities, sometimes formed of cellular tissue only, and sometimes of very little cells mingled with a great number of vessels; in other respects, they do not appear to differ essentially from the tubiform reservoirs we have already mentioned under the name of proper vessels.

#### CLASSIFICATION OF THE ORGANS AND FUNCTIONS OF VEGETABLES.

30. The functions of vegetable are referred to two classes. One belongs to the individual life of the vegetable, that is, the functions which effect its nutrition: the other refers to its multiplication or the preservation of the species.

31. The parts of plants that serve the functions of nutrition, are the roots, the stem, and the leaves.

32. The parts which are especially designed to secure the multiplication of plants are the organs of fructification; namely, the flowers and fruits.

### LESSON II.

**FUNCTIONS OF NUTRITION.**—*Absorption and Ascent of Sap—Roots, their Structure and Forms—Stem, its Divisions, Varieties, &c.—Structure of the Stem in Ex'ogens—Medullary Canal—Pith—Medullary Sheath—Wood—Medullary Rays—Bark—Epidermis—Cork—Structure of the Stem in End'ogens.*

#### FUNCTIONS OF NUTRITION.

1. The phenomena of the life of nutrition in plants are referred to five distinct functions; namely,

27. What is scurf?

28. What are prickles? How do they differ from thorns?

29. What are glands?

30. How many kinds of functions do plants possess?

31. What parts serve the function of nutrition?

32. What parts serve the function of multiplication, or reproduction of plants?

1. What are the several functions of the life of nutrition?

- 1st. The absorption of nutritive matter :
- 2d. The transportation of the nutritive liquid or sap to the organs of respiration.
- 3d. The process of respiration and elaboration (or preparation) of the nutritive juices in the interior of the respiratory organs.
- 4th. The transportation of the sap thus elaborated to different parts of the plant, and the deposition or assimilation of its elements in its various parts.
- 5th. The secretion of peculiar juices effected by special organs.

2. The roots of plants absorb the nutritive matter necessary for the maintenance of vegetable life, and the liquids, thus introduced into the body of the vegetable, constitute what is called the *ascending sap*. This sap rises through the stem by means of particular canals, and in this manner reaches the leaves and other green parts of plants; there it is modified by the effects of transpiration and of respiration, and after having been thus prepared, the sap descends, following a new route, and is distributed to those parts for the growth of which it is destined.

We will study successively these phenomena, and the organs which are the seat of them, both in vascular and cellular plants.

#### OF THE ABSORPTION AND ASCENT OF SAP.

3. The absorption of nutritive matters is principally effected by the extremity of the roots, and by passing through these organs and mounting along the stem, they reach the leaves, in the substance of which the alimentary juice is rendered fit for the nutrition of the plant. These two phenomena, the absorption and ascent of the sap, are very intimately united; and in order to understand them, we must, in the first place, study the structure of the two portions of the plant which are the seat of them, namely, the roots and stem.

#### OF THE ROOT OR DESCENDING AXIS (RADIX).

4. We give the name of *root* to that inferior portion of plants which serves to fix them in the soil, and which, by its growth, increases in length in an opposite direction to the stem.

5. With the exception of some plants that live under water, or float upon its surface, all vegetables are provided with roots,

2. What is ascending sap? What becomes of this *ascending sap*?
3. Through what part of a plant is matter chiefly conveyed for its nourishment.
4. What is meant by the root of the plant?
5. Are all plants provided with roots? Where are the roots usually found? What are adventitious roots?

and these organs are almost always buried in the earth. Sometimes the roots float freely in the water, and there are some plants that insinuate them into cracks in walls, or in crevices of the stem of some other plant, as the mosses, for example. There are certain plants, the roots of which arise at a considerable distance above the surface of the soil, and have only their extremity buried in the earth, so that the greater part of their length remains exposed to the air. To such roots we give the name of *aerial* or *adventitious* roots; the maize or Indian corn and many other American plants have them.

6. We see now that it is not a constant character of roots to be covered up in the earth; and, on the other hand, we should be equally deceived if we were to regard as roots all parts of plants that are buried in the soil; for it sometimes happens that the stem, instead of rising up through the air, creeps horizontally under ground; but the structure of the two parts is different, and prevents them from being confounded with each other. The tissue of roots is whitish, and never becomes green by exposure to the action of light, which occur to all other parts of plants. [Those stems which creep along under the ground, are called root-stalks, or subterranean, or *rhizome* (from the Greek *rhiza*, root) stems; the stems of the orris root, ginger, and potato, upon which grow the tubers we eat, are instances of this kind.]

7. The root, considered as a whole, generally consists of three distinct parts: First, the body or middle part, which is sometimes globular, and, at others, similar in form to a descending stem; Second, the *radicles*, the more or less delicate fibres which terminate the root at its lower part; and, third, the neck or *collum*, the point that separates it from the stem, and which is often marked by being smaller.

8. The internal structure of roots varies; in general, it is divided into the *cortical* part, or *bark of the root*, and *central* or *ligneous* part.

9. The *bark of the root*, which is often very thick, is entirely composed of cells; its epidermis is always without stomata.

10. The *ligneous body of the root* is not ordinarily composed of distinct fibres, and we do not find tracheæ in it as in the stalk or stem of vascular plants; nor has it pith in the centre.

6. Are roots always under ground? Does the stem ever grow under ground? How is a root distinguished from a stem that grows under ground? How is the tissue of roots characterized? How are those stems which grow under the soil designated?

7. How is the root divided?

8. How is the internal structure of roots divided?

9. What is the structure of the bark of the root?

10. What is the ligneous body of the root?



11. The extremities of the radicles are unprovided with epidermis, and are composed only of rounded cellular tissue; these parts are called *spongioles* (little sponges), and, as we shall presently see, play a very important part in absorption.

12. The general form of roots varies much, and gives rise to numerous distinctions, the chief of which are the following:

### DIVISION OF ROOTS.

Roots are primarily divided into *Simple* and *Compound* or *Multiple* Roots.

**SIMPLE** ROOTS have a single base continuous with the stem; they are called

*Tap-roots*, when they descend perpendicularly, and have almost the whole of their spongioles united at their extremity. These are

*Fusiform*, when they are shaped like carrots, and

*Napiform*, *Tuberous*, &c., when they are swelled and rounded like turnips.

*Fibrous*, when they are very branching and ordinarily furnished with numerous spongioles. These are

*Knotted*, when they present swellings along the course of their fibres, and

*Creeping*, or *Repent*, when they run along near the surface of the soil.

The second primary division of roots is

**THE COMPOUND** ROOTS: they arise in great numbers from the neck of the plant. They are said to be

*Branching*, or *Capillary*, when each fibre, which is distinct at its origin, gives off branches in abundance;

*Knotted*, when the fibres have swellings or knots in their course; and

*Fusiform*, or *Fasciculate*, when they are formed by the union of a great many more or less elongated tubercles.

13. We may add that roots are said to be *fleshy*, when they are more succulent (juicy) and larger than the base of the stem, and *ligneous*, when their tissue resembles wood. They frequently present swellings or *tubers*, which are always masses of nutritive matter destined to supply the wants of the plant at a certain period.

14. Finally, we give the name of *adventitious roots* to those which, in certain instances, arise from the stem, but are in other respects analogous to ordinary roots. (See pages 63 and 64.)

### OF THE STEM (CAULIS).

15. We give the name of **STEM** (*Caulis*, *Stalk*) to that part of plants which is intermediate between the roots and the leaves.

11. What are *spongioles*?

12. What is a simple root? What is a tap-root? What is a fusiform root? What is a napiform root? What is a fibrous root? What is a knotted root? When is a root said to be creeping? What is a compound root? What is a capillary root?

13. What is meant by a fleshy root? What is meant by a ligneous root? What is the use of those swellings or tubers found on certain roots?

14. What are *adventitious* roots?

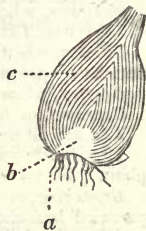
15. What do you mean by stem?

16. The stem grows in an opposite direction to the root, and seeks the air and light; in general, it rises vertically above the soil, and serves to support the leaves, flowers, and fruit.

17. Generally this part of a vegetable is very apparent and easily recognised; sometimes it is simple, at others branching, and when it is simple below, and branching in its superior part, the first part is called the *trunk*, and to the second we give the name of *branches*.

18. All vascular plants are provided with a stem, but sometimes it is so short and so enveloped in leaves, or so completely hidden in the ground, that it seems not to exist; vegetables thus formed, are named *a'caulous* plants (from the Greek, *a*, without, and *kaulos*, stem or stalk); but this absence of the stem is only in appearance.

19. Thus, in tulip and other bulbs, there exists amidst the leaves in form of scales, of which the greater part of these bodies is composed, a tissue which separates these appendages from the roots, and which constitutes a true stem (*fig. 11*); only, instead of being elongated and cylindrical, as is ordinarily the case, it is generally globular and flattened above, an arrangement which has procured for it the name of *cormus* or *plateau*.



*Fig. 11.—BULB.*

20. Subterraneous or *rhizome* stems have the appearance of roots, but are distinguished from them by their structure and several other characters; their tissue becomes green by the action of light, which is never the case in true roots, and, under the influence of moisture, branches spring up covered with leaves, but radicles never grow from them. Sometimes these subterraneous stems bear, here and there, irregular tubercles.

21. The stem of a plant assumes numerous and very different appearances in different plants.

*Explanation of Fig. 11.*—A bulb or onion, showing the roots (*a*);—the *cormus*, or *plateau*, or representative of the stem (*b*);—and the leaves or scales (*c*); *Cormus* (from the Greek *kormos*, a stem), a rhizome, or subterraneous stem.

16. In what direction does the stem grow? What is the use of the stem?

17. What is meant by trunk and by branches?

18. Are all plants provided with a stem?

19. What is a *cormus*?

20. How are subterraneous stems distinguished from roots? What is the effect of light on the colour of plants?

21. Is the form of the stem in all parts the same? What are the forms? What is a *scape*?

If *above ground*, it is root-shaped, or knotted; ascending; creeping; articulated; leafless, succulent, and deformed; or leafy.

If it *bears the flowers*, proceeding immediately from the soil or near it, it is a *scape*.

22. The stem, in most plants, rises vertically in the air, but sometimes it wants strength to sustain itself, and rests drooping on the surface of the ground, to which it often attaches itself by roots (stems of this kind are named *repent* or *creeping*), or they sustain themselves upon some other more robust plant, as is seen in the climbing plants, &c. It is observed that the latter often wind themselves spirally round whatever supports them; they are then called *twining* or *voluble*; and it is worthy of note, that the direction according to which different individuals of the same species wind themselves, never varies; in some, such as the haricot or bean, and bind-weed, it is from right to left; in others, such as the honeysuckle and hop, it is constantly from left to right.

23. While young, stems are always of a soft consistence and similar to grass; they often remain in this state, and live but a year; they are then called *herbaceous stems*. In other instances they acquire more or less hardness, their interior is transformed into wood, and they live out of the ground many years: in this case they are called *ligneous stems*.

24. When the stem, although it be persistent, remains watery and more or less soft, it takes the name of *fleshy stem*.

25. We generally apply the name of *shrub* to those plants with a ligneous stem which branch at their base, and do not much exceed a man in height, such as the rose or lilac; and we give the name of *tree* to those with a ligneous (woody) stem that branch only at the superior part, and rise to a considerable height. The *branches* are only divisions of the trunk which diverge more or less from it, and are again subdivided in their turn; upon their arrangement depends the general form of the plant; sometimes they stand up, which gives the tree a pyramidal form; sometimes they are spread out, and at others they are pendent or hanging.

26. Stems of certain plants present at intervals knots or enlarge-

22. What is meant by a creeping stem? What is meant by twining or voluble stems? What is especially remarkable in these stems?

23. What is an herbaceous stem? What is a ligneous stem?

24. What is a fleshy stem?

25. What is a shrub? How does a tree differ from a shrub?

26. What is a culm?





Fig. 12.—DATE PALM.

ments, produced by an induration and a swelling of their tissue; when they are also hollow internally, they are designated under the name of *culm* or *straw*. The stems of wheat, barley, and oats are of this kind.

27. We give the name of *stipe* to stems which resemble a round column, as large above as below, and crowned with a cluster of leaves or flowers, like the stems of palms (fig. 12).

28. The stem of all vascular plants is composed of fibres arranged in bundles (*fasciculi*), or layers, and variously surrounded by cellular tissue; but we observe very great differences in their structure; and these variations, which coincide with differences not less important in their mode of growth, have caused vascular plants to be divided into two groups; namely, *EX'OGENS* and *EN'DOGENS*.\*

\* *EX'OGENS* (*Ex'ogenous plants*). From the Greek, *ex*, from, and *geinomai*, I grow. A term applied to those plants, a transverse slice of whose stem exhibits a central cellular substance or pith, an external cellular and fibrous ring or bark, and an intermediate woody mass, and certain fine lines radiating from the pith to the bark through the wood, and called medullary rays. They are called *EX'OGENS*, because they add to their wood by successive external additions; and are the same as what are otherwise called dicotyledons. They constitute one of the primary classes into which the vegetable world is divided, characterized by their leaves being reticulated; by their stems having a distinct deposition of bark, wood, and pith; by their embryo having two cotyledons; and by their flowers being usually formed on a quinary type.

*EN'DOGENS* (*En'dogenous plants*). From the Greek, *endon*, within, and *geinomai*, I grow. One of the primary classes of plants, so called because their stems grow by successive additions to the inside. They are usually

27. What is a *stipe*?

28. What is the nature of the stem in vascular plants? How are vascular plants divided?

29. The CLASS OF EX'OGENS comprises all the trees and shrubs of our forests, and is composed of vascular plants, the stem of which has a medullary canal in the centre, and grows by super-posed layers (*fig. 13*).

30. The CLASS OF EN'DOGENS comprises those plants in which the stem has neither a central canal nor concentric layers (*fig. 14*). The palms belong to this division.

### *Structure of the Stems of Ex'ogenous Plants.*

31. In the stems of these plants we distinguish two principal parts: the *bark*, and the *central*, or *ligneous part*, which might be called the *body of the stem*. Each one of these portions is in turn composed of several different parts; the central portion of the stem is formed by a central pith, by ligneous layers, and by medullary rays; the bark, or cortical portion, is composed of the epidermis of a cellular envelope, and of a fibrous part named *liber*, or cortical layers. (*Liber*, Latin, bark, is the interior lining of the bark of ex'ogenous plants.)

32. If we cut through an elder, or any other ex'ogenous tree, transversely, we observe in the centre a canal, which is ordinarily angular, or very nearly cylindrical, and which, in the young branches, if not in the whole plant, is filled with a round cellular tissue (*fig. 13, a*); this cavity is called the *medullary canal*, and the cellular tissue found in it is named the *pith* of the plant.

33. This central pith is of a soft consistence, and of a very homoge'neous\* structure; while young it is always humid, and of a light greenish tint; but with the progress of age, the cells of which it is composed become empty, dry, and assume a remarkable whiteness; sometimes it is torn by the effect of the elongation of the stem, and separates in laminæ or bundles, as may be easily seen in branches of jasmine that have attained one year old.

known by the veins of their leaves running parallel with each other, without branching or dividing. Grasses, lilies, the asparagus, and similar plants belong to this class, which in warm countries contains trees of large size, such as palms and screw pines.

\* Homoge'neous. From the Greek, *omou*, together, and *genas*, kind. Of the same kind. Bodies whose constituent elements are of one and the same kind, are said to be homoge'neous.

29. What is the general character of those plants which constitute the class of Ex'ogens?

30. What kind of plants does the class of En'dogens comprise?

31. How is the stem of ex'ogenous plants divided? What is the central portion? What is bark?

32. What is the *medullary* canal of plants? What is meant by *pith*?

33. What is the character of pith?

34. In herbaceous plants, and in ligneous plants of very rapid growth (such as the elder), the space occupied by the pith is very considerable; but in trees, the wood of which is very hard, such as the oak, the medullary canal or sheath is generally very small.

35. The parietes of the canal, containing the central pith, called the *medullary sheath*, are formed of longitudinal fibres, ordinarily arranged in a circle, and of a layer composed of tracheæ, false tracheæ, and porous vessels. It is the only part of the stem in which true tracheæ have been observed.

36. Between the medullary canal and the bark, is the *ligneous body*, or wood, which is composed of concentric layers, the number of which is more or less considerable, according to the

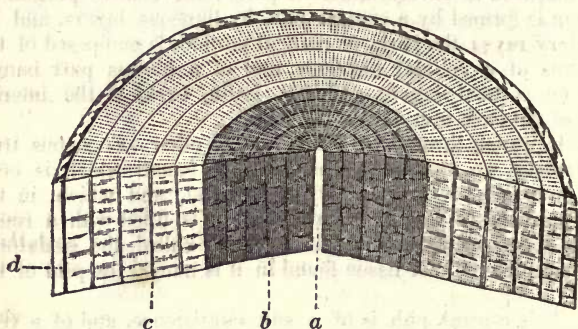


Fig. 13.—TRANSVERSE SECTION OF AN EX'OGENOUS STEM.

age of the plant (*fig. 13, b, c*); each of these layers is composed of longitudinal fibres, united to the subjacent layer by cellular tissue. These fibres are formed nearly in the same manner as those of the medullary sheath, except that no tracheæ are found in them; they are composed only of clostres or elongated cells, or dotted or rayed vessels.

37. The ligneous body constitutes what is generally termed *wood*; its central portion is harder than its external part, and is

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*Explanation of Fig. 13.*—Transverse section of an ex'ogenous stem:—*a.* the pith;—*b.* layers of the heart of the wood;—*c.* layers of the *albur'num* or sap-wood;—*d.* the bark.

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34. How does the pith vary in quantity in different plants?

35. What is meant by medullary sheath? What is remarkable in its structure?

36. What is meant by the ligneous body? How is it formed?

37. What is wood? What is meant by true wood? What is meant by albur'num? In what respect does *true* differ from *sap* wood?



ordinarily of a different colour : it is this part which is commonly called the *heart of the wood*, and which botanists designate under the name of *true-wood*, *heart-wood*, or *duramen*, while they give the name of *albur'num* or *sap-wood* to the external ligneous layers, the solidity of which is less, and the colour whiter (*fig. 13, c*). In other respects the structure of these parts is the same, only the ligneous fibres of the *true* or *perfect wood* are filled with solid matters deposited in their interior, while the proportion of liquids is more considerable in the *sap-wood* or *albur'num*. In trees of slow growth the line of demarcation is very distinct between the heart and sap-wood, and in the coloured woods, such as ebony, mahogany, &c., it is the heart only that possesses their peculiar colour, the sap-wood being usually white. In trees of very rapid growth, such as the poplar, willow, &c., there is, on the contrary, but little difference between these two ligneous layers. As we shall see in the sequel, the *albur'num* is gradually converted into perfect wood, and it is by the formation of new ligneous layers between those already formed and the bark, that the stem increases in thickness.

38. The *medullary rays* are the divergent lines which run from the centre of the stem towards its circumference ; they are composed of vertical laminæ of compressed cellular tissue, and are very analogous to the pith, from which they seem to arise. These rays come in part from the external ligneous layers, and terminate in the bark, thus establishing a communication between the superficial and central parts of the stem.

39. The *bark* is composed first of a layer of cellular tissue, which constitutes the epidermis, and of a deeper layer formed of clostres grouped together so as to form fibres, but without being united with tracheæ ; in the progress of age, new alternating zones of cellular tissue and fibres, are formed beneath the preceding, and there results from it a series of super-posed layers, which resemble those of the wood, but differ from them essentially in their mode of growth ; we have observed that the latter are formed successively one on top of the other ; in the bark, on the contrary, growth takes place from without inwards.

40. We give the name of *liber* to the inner layers of the bark, because they are easily detached in thin plates or laminæ, and because the ancients made use of it, as we do paper, to write upon.\*

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\* Some of our young readers may remember the Latin word, *liber*, and its several versions, given as follows :

“ *Liber*, book ; *liber*, tree ;  
*Liber*, child, and *liber*, free.”

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38. What are medullary rays ?

39. How is bark formed ? In what respect does bark differ in its manner of growth from wood ?

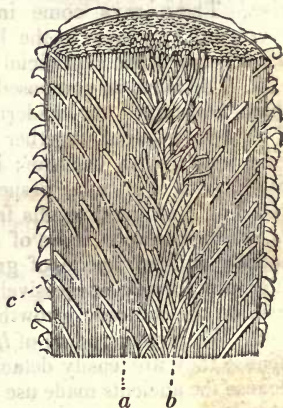
40. What part is called *liber* ?

41. The external layer of cellular tissue constitutes the epidermis, and is what botanists term the *herbaceous envelope* of the bark. In the course of the growth of the subjacent parts, it soon becomes strongly compressed, and at a certain epoch, we see it crack and tear in flexible laminae, or detach itself in scales or patches; the neighbouring cortical layers undergo the same alterations, and when the part of the bark thus modified has been raised up, the laminae of cellular tissue thus exposed becomes for a brief period a kind of epidermis, until it is itself in turn detached. For this reason the thickness of the bark is never very considerable, and its surface is continually renewed. In some plants the herbaceous layer becomes very much developed, and the portion of bark that is thus separated is of sufficient consistence and thickness to be very useful to us in the arts. Cork, for example, is only the superficial part of the bark of a particular species of oak, —*quercus robur*,—which detaches itself from the *liber* every eight or nine years, and it may be removed more frequently without any danger of destroying the tree.

42. Bark often contains, in its interior, cavities which are reservoirs of proper juices, and, in particular, those called the *vessels of the latex*.

### *Structure of the Stem of En'dogenous Plants.*

43. The stem of these plants, that of a palm, for example (*fig. 14*), is formed of a considerable mass of cellular tissue, analogous to pith, through which penetrate bundles of fibres in various ways, but never forming concentric layers, as in the ex'ogenous plants. Each of these fibres is composed of elongated cellules, of large dotted vessels, of tracheae, of proper vessels, and of polyhedral cells; they are closer together near the centre of the stem than towards its circumference, and their superior extremity is abruptly curved outwards to be continued into the



*Fig. 14.*—SECTION OF AN ENDOGEN.

*Explanation of Fig. 14.*—Section of the stem of an en'dogenous plant, (a palm);—*a*. cellular tissue;—*b*. fibres;—*c*. external pellicle.

41. What is epidermis? How is it formed? What is cork?

42. What does bark contain?

43. What is the structure of the stem in en'dogenous plants?

leaves (c). It is to be remarked also, that in general there is no distinct bark, and that the external pellicle never grows in layers, as is the case in the Ex'ogens.

CELLULAR PLANTS never present parts that are really analogous to the organs we have just spoken of, and to which we shall again recur.

### LESSON III.

#### MECHANISM OF THE ABSORPTION AND ASCENT OF THE SAP.

*—Ascending Sap—Exhalation—Respiration—Leaves—Parts of Leaves; their Structure, Shape, and Position—Stipules—Tendrils—Examples of the Forms of Simple and Compound Leaves—Exhalation—Respiration—Distribution of the Nutritive Juices—Descending Sap—Secretions—Excretions—Succession of Crops—Proper Juices—Lignin—Fecula—Growth of Plants—Grafting—Effects of the Seasons on the Nutrition of Plants—The Age of Plants.*

#### MECHANISM OF THE ABSORPTION AND ASCENT OF THE SAP.

1. It is by the process of absorption that plants derive from the soil in which they are fixed, the nutritive matters necessary for their growth and the maintenance of their existence.

2. The nutritive matters, to be pumped up in this manner, must necessarily be in a fluid state; in the solid form they could not be absorbed; and it is, in fact, water holding various substances in solution, that thus penetrates the plant and serves for its nourishment.

3. It is chiefly, and sometimes exclusively, by the extremity of the roots that this operation is effected. The epidermis, which covers almost the whole plant, in general offers obstacles to the passage of these liquids; but the spongioles, as we have already seen, are unprovided with this envelope, and constitute a cellular tissue which gives a ready passage to water; for this reason we must consider these spongioles as the chief organs of absorption.

4. Some plants also absorb by the leaves; and when the

1. By what process do plants derive nourishment from the soil in which they grow?

2. In what state or condition must the food of plants be before it can nourish them?

3. What are the chief organs of absorption? How is this operation effected?

4. Is absorption carried on by the roots alone?



stem of a plant is cut across, its internal tissue being thus laid bare, also pumps up water in which it may be placed ; but in the ordinary state of a plant, these cases are exceptions, and the absorption of liquids is carried on in the most active manner by the spongioles.

5. It has been remarked that water, rendered thick and viscid by the presence of foreign substances, was absorbed very slowly and with difficulty, but when its fluidity is not diminished by matters that it holds in solution, it penetrates vegetables just as if it were pure. Now, the water which reaches the roots of plants always holds in solution a greater or less quantity of air, earthy salts, and organic matter ; and consequently it introduces these substances into the interior of the plant, which is either benefited or injured according as they are proper for its nutrition, or as they exert an injurious influence upon its organs.

6. The liquids thus absorbed by the roots constitute the *ascending sap*, which rises through the stem to reach the leaves.

7. The ascent of the sap is always effected through the ligneous body ; and it is remarked that it takes place more actively through the albur'num than through the perfect wood.

8. It is not known with certainty by what way the absorbed liquids rise up in this manner ; many botanists think that it is only by the intercellular passages ; others believe that it is by the vessels ; and in fact, if we place the roots of a plant in coloured water, we are not long in perceiving that the vessels of the stem assume the same colour, which seems to indicate that it is through these tubes that the liquids mount up towards the leaves. Nevertheless, under ordinary circumstances, we find these vessels empty, or at least filled with air, and it would seem that it is chiefly through their interior that the air, absorbed by the roots, rises in the stem of the plant.

9. The rapidity and force with which the ascent of sap takes place, are sometimes extremely great. In the experiments made upon this subject, it has been shown that a branch of an apple tree cut across and surmounted by a tube, raised water contained in the latter several feet in the space of some hours ; and what are called *vine tears*, is nothing but the ascending sap, which escapes in abundance when the plant is trimmed. In other experiments made to ascertain the force with which the sap

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5. How are earthy salts introduced into the substance of living plants ?

6. What constitutes the ascending sap ?

7. Through what part of the plant does the sap ascend ?

8. What is the manner of the ascent of the sap ?

9. What is the force and rapidity of the ascent of the sap ?

mounts in the grape vine, it was found to be sometimes so great as to sustain the weight of a column of water, over forty feet in height.

10. The circumstances that have most influence upon the ascent of the sap are heat and light.

### OF EXHALATION AND RESPIRATION.

11. To render it fit for the purpose of nutrition, the ascending sap undergoes, in the interior of the plant, considerable changes; these changes are the result of two important phenomena; namely, exhalation and respiration.

12. The leaves are the chief seat of these two functions, and must be regarded as their special organs. We will now study their structure.

### OF LEAVES.

13. The leaves of vascular plants are the lateral appendages of the stem, formed of more or less distinct fibres and cellular tissue, enclosing, in its interior, a great deal of green colouring matter.

14. The fibres of the leaf are the continuation of those of the stem, but ordinarily they contain more tracheæ; in general, they form at first a cylindrical fasciculus (bundle), caniculated (that is, hollowed in a gutter on the opposite side), or laterally compressed, which is named *petiole*, or leaf-stalk; then they expand and join again to form the flat part called the *blade* or *limb* of the leaf. When the fibres separate immediately on springing from the stem, the leaf has no pedicle or petiole, and is then said to be *sessile* (from the Latin, *sedeo*, I sit). The petiole of dicotyle'donous\* plants is separated from the stem by an articulation or joint, that is, a line at which its tissue offers but little resistance, the cells and vessels of which it is composed being placed end to end, instead of being mingled as usual; it is on account of this arrangement that the leaves fall when they fade, while those of which the *limb* or *blade* arises directly from the stem are destroyed only little by little, and remain adherent at their base. The first are called caducous, or articulate leaves,

\* DICOTYLE'DONOUS. (From the Greek, *dis*, double, and *kotyledôn*, a seed leaf.) Having a double seed-leaf or seed-lobe.

10. What circumstances most influence the ascent of the sap?

11. Does the ascending sap undergo any change in the interior of plants?

12. In what part of plants do exhalation and respiration take place?

13. What are leaves?

14. How are leaves formed? What is the petiole? What is the limb of a leaf? When is a leaf said to be sessile? What are caducous or articulate leaves? What are persistent leaves?

and to the second we give the name of *persistent*; the leaves of fir trees are persistent.

15. When all parts of the leaf are equally adherent to each other, it is named a *simple leaf*, whatever may be the divisions of its blade; for example, the leaves of the lilac, the ranunculus, of the vine, &c. (see figs. 17 to 57); sometimes the same tail or peduncle supports several petioles, each of which is articulated upon this peduncle, as it itself is upon the stem, and then this assemblage is called a *compound leaf*. (Examples of compound leaves are seen in the sensitive plant, the leaves of the acacia, of the chestnut, &c. See figs. 58 to 74.)

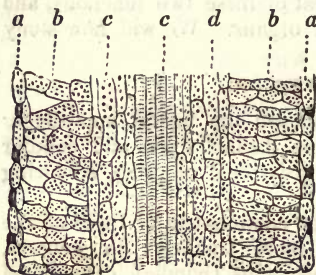


Fig. 15.—SECTION OF A LEAF.

16. The fibres, by expanding in the limb, constitute the *nerves* of the leaf, and the cellular tissue lodged between these bundles of fibres, thus ramified, constitutes the *paren'chyma*\* of the leaf (fig. 15).

17. The form of the leaf depends principally upon the disposition of the nerves; in general, the nerves expand on a single plane so as to form a plate or membrane with two

surfaces, a superior and an inferior; but they sometimes ramify in all directions, and then give rise to leaves characterized by being thick, cylindrical, triangular, or swelled, as we observe in certain fleshy plants. The large nerves that arise immediately from the petiole are called *primary nerves* (figs. 25 and 26); those which arise from the latter are *secondary nerves* (fig. 28); we sometimes give the name of *tertiary nerves* (fig. 43) to those ramifications which spring from the *secondary nerves*, and we apply the name of *veins* of the leaf to those terminal divisions of the nerves which are visible to the eye, but too small to make any projection on the surface. [The veins are merely a continuation

\* PAREN'CHYMA (pronounced *paren'-ke-ma*). From the Greek, *pareg-chuein*, to strain through. The spongy and cellular tissue of vegetables and animals is so called.

*Explanation of Fig. 15.*—Section of a leaf showing the epidermis (a, a);—the paren'chyma (b, b);—the dense cellular tissue (c, c);—and the vessels (d) of which its fibres are composed.

15. What is a simple leaf? What is meant by a compound leaf?

16. What are the nerves of a leaf? What is paren'chyma?

17. Upon what does the form of the leaf depend? What are primary nerves? What are secondary nerves? What are the veins of leaves?



of the nerves, and both are constituted of the same fibres and vessels. It must not be supposed from the names that have been arbitrarily given them, that these parts are similar in function to those parts of animals of the same name.

18. Sometimes the leaf presents one or more primary nerves which diverge in a straight line from the base of the blade, and give rise to more slender nerves, that separate from each other, following a straight line, and forming an angle with the first (*fig. 28*): at other times the principal nerves are curved from their base (*fig. 34*).

19. We give the name of *angu'linerve leaves* to those in which the primary and secondary nerves are straight, and form angles with each other (*fig. 26*), and we call those *curvinerve leaves* in which the primary nerves are curved (*figs. 37 and 43*). The first belong chiefly to ex'ogenous or dicotyle'donous plants, and the second to en'dogenous or monocotyle'donous plants. (Monocotyle'donous.—From the Greek, *monos*, single, and *kotyledôn*, seed-lobe. Applied to plants that have but one seed-lobe or coty'ledon in the embryo.)

20. The *angu'linerve leaves* present four principal arrangements; sometimes they are *penninerve*; that is, provided with a middle nerve (called also midrib), which is a prolongation of the petiole, and which gives off to the right and left secondary nerves, like the feathers of a pen (for example, the olive leaf, *fig. 22*, the leaf of the yoke-elm, and of the beech tree); sometimes they are *palminerve*, that is, provided with several primary nerves which separate from each other at the base of the blade, like the divisions of a fan (*fig. 28*); for example, the leaf of the grape vine, which has five primary nerves, and that of the mallows, in which we count seven or even nine: the number of these nerves is always unequal, and that of the middle appears to be the prolongation of the petiole; *peltinerve* (*fig. 45*), that is, provided with nerves that radiate on an oblique plane relatively to the petiole, so as to constitute a sort of disk or shield, placed upon its peduncle (foot), (for example, the leaf of the nasturtium); and in others again they are *pedalinerve*, that is, having a very short central nerve or midrib, from which spring two largely developed lateral nerves, the ramifications of which are very small towards the external side (edge) of the leaf and very

18. Are the nerves of all leaves alike in arrangement?

19. What are angulinerve leaves?

20. What is a penninerve leaf? (Penninerve, from the Latin, *penna*, pen or feather.) What is a palminerve leaf? (Palminerve, from the Latin, *palma*, palm of the hand.) What is a peltinerve leaf? (Peltinerve, from the Latin, *pelta*, a shield.)

strong towards the centre of the blade, like the leaves of the foetid hellebore (*fig. 72*), and some of the arums, for example.

21. The *curvinerve leaves*, in general, have a great number of slightly projecting nerves, which most generally ramify near their summit, and are often nearly parallel in the greater part of their length (for example, the leaves of the narcissus and *fig. 37*).

22. It sometimes happens that the space comprised betwixt the nerves is not filled by cellular tissue, which produces a very singular arrangement; the leaf is then full of holes and resembles a trellis-work (for example, the leaves of the *Hydrogeton fenestralis*); or the holes are irregular, as we see in the leaves of the *Dracontium pertusum*.

23. At other times the cellular tissue which surrounds the nerves is spread out in such a way as to completely unite them to their utmost extremity, in which case the leaf is said to be *entire* (for example, the leaf of the lilac, and of the olive, *figs. 22, 52, and 53*). But between these two very different modes of conformation, there is a great number of intermediate degrees. Sometimes the paren'chyma completely unites all the ramifications of a secondary nerve, but does not extend between the different nerves that arise from the primary nerve, so that the blade is divided into several *segments* or *lobes*; sometimes these lobes are joined at the base or as far as the middle of their length, and then the leaf is said to be *partite* or divided, and the intervals between the lobes are called *fissures* (*fig. 32*). According to the number of these fissures or divisions, the terms *trifid*, *quinquifid*, &c., are used. In some instances this junction is complete, but the paren'chyma which separates the last nerves does not extend entirely to their extremity, and the edges of the leaf are then *dentate*, as in the rose (*fig. 47*). When these small marginal divisions are rounded instead of being pointed, they are called *crenulations*, and the leaf is said to be *crenulate* (*fig. 41*).

24. The two surfaces of the leaf are ordinarily covered with an epidermis, which often has hairs upon the nerves, and stomata on the paren'chyma; these appendages and orifices are, in general, especially numerous on the inferior surface; and on this account it is almost always paler than the superior surface of the

21. What is remarked of curvinerve leaves?

22. Is the space between the nerves of the leaves always filled by cellular tissue?

23. What is meant by an *entire* leaf? When are leaves *partite*? What are *fissures* of leaves? What is the difference between a *dentate* and a *crenulate* leaf? (*Dentate*, from the Latin, *dens*, a tooth.)

24. Why is the inferior surface of a leaf generally palest? What is found in leaves besides the nerves and cellular tissue?

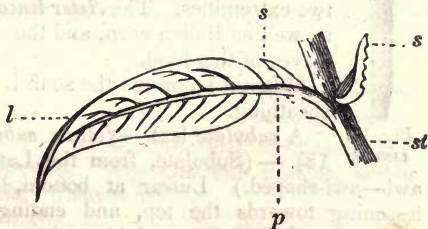
leaf. Sometimes there are no stomata on the superior surface, and the arrangement of the cells of the paren'chyma is not the same as beneath. In the thickness of the leaf there are, ordinarily, cavities or intercellular lacunæ which contain air, and communicate externally through stomata (*figs. 9 and 10*); sometimes we also find in the paren'chyma, glands or reservoirs of the proper juices.

[The distribution of the vascular tissue through the limb of the leaf is termed its *venation* or *nervation*, because the course of the vessels (of which these nerves are made up) have been supposed to bear some resemblance to the distribution of veins and nerves in certain parts of the animal structure. The bundles of vessels constituting the nerves, maintain nearly a parallel course in their passage through the petiole, and are closely condensed together; but on arriving at the limb they separate, and, as we have seen, are distributed in various ways. It will be observed they may all be referred to one or the other of two classes, called the angulinerve and curvinerve arrangement.]

25. The position of the leaves on the stem and branches varies in different plants, and furnishes very useful characteristics to botanists for the distinction of species; sometimes they are *opposite*, that is, they rise in pairs at the same point from two sides of the stem or peduncle (*fig. 70*); sometimes they are *verticillate*, that is, grouped, three or more together, around the same part of the stem; and at other times they are *alternate*, that is, they arise separately at different points.

26. It is remarked, also, that opposite leaves are almost always so arranged that the different pairs cross each other. When they touch each other at the base, instead of arising from the opposite sides of the stem, they are called *gemini*, or *geminatæ* leaves.

27. On the stems of many plants, we observe on both sides of each leaf, small organs named *stipules*, which seem to be very analogous to leaves, but their nature is not fully ascertained (*fig. 16, s, s*). They are only found in the dicotyledonous plants, and they sometimes resemble little leaves, at others, scales.



*Fig. 16. — STIPULES.*

*Explanation of Fig. 16:—s, s, stipules arising at the axil of the leaf, that is, where the petiole joins the stem;—l, leaf;—p, petiole;—st, stem.*

25. When are leaves opposite? When are leaves said to be verticillate?

26. When are leaves geminate?

27. What are stipules? To what description of plants are they confined? What is their use?



[Whatever arises from the base of a petiole, or of a leaf, if sessile, occupying the same place, and attached to each side, is considered a stipule. The appearance of this organ is so extremely variable, some being large and leaf-like, others being mere rudiments of scales, that botanists are obliged to define it by its position, and not by its organization.

Stipules, the margins of which cohere in such a way that they form a membranous tube sheathing the stem, are called *ochreæ*.—*Example*, the rhubarb.—*Lindley*.]

28. The filamentous appendages, known under the name of *tendrils*, which twine themselves round neighbouring bodies, serve to sustain weak and climbing plants, are frequently petioles or stipules, modified in a particular manner, but they are also often formed by the peduncle of flowers that have proved abortive in development.

29. According to their duration on the stem, the leaves are

*Caducous*, when they fall early, as in the plane tree.

*Deciduous*, when they fall before the new leaf appears, as in the horse-chestnut, and most other trees.

*Marcescent*, when they wither before falling, as in the oak, and many other trees.

*Persistent* or *Evergreen* (*Sempervirens*), when they remain on the vegetable one winter or longer, as the ivy, the pine, the myrtle, the common laurel, &c. Plants of this kind are called evergreens.

The various shapes of leaves, and the names given to them, as well as the variety of their margins, may be seen in the following

#### EXAMPLES OF THE FORMS OF SIMPLE LEAVES.

The side or edge of the leaf in which the petiole is inserted, is termed the *base*, and the opposite extremity, the *apex* of the leaf.



A *linear* leaf—*folium lineare*—(*fig. 17*).—(*Folium*, Latin, a leaf; *lineare*, Latin, line-shape.) The two edges straight and equidistant throughout, except at the two extremities. The *Aster linearifolius*, the star-flower, as well as Indian corn, and the grasses generally, have leaves of this kind.

When it embraces the stem it is *vaginate* or sheathing.

*Fig. 17.* A *subulate* leaf—*folium subulatum*—(*fig.*

*LINEAR.* 18).—(*Subulate*, from the Latin, *subula*, an awl—awl-shaped.) Linear at bottom, but gradually lessening towards the top, and ending acute. The *Phascum subulatum*, one of the mosses, and the jonquil, have a leaf of this description.



*Fig. 18.*  
SUBULATE.

28. What are tendrils?

29. What is the difference between a caducous and a deciduous leaf? (*Caducous*, from the Latin, *cado*, I fall. *Deciduous*, from the Latin, *decido*, I fall off.) When are leaves said to be marcescent? (*Marcescent*, from the Latin, *marceo*, I wither.) What are persistent leaves? (*Persistent*, from the Latin, *per*, through, and *sisto*, I remain.)

An *a'cerose* leaf (from the Latin, *acer*, a needle), in the form of a needle, is seen on pines; it is linear acuminate.

An *obtuse* leaf—*folium obtusum*—(fig. 19), blunt pointed; the apex is broader than the base, and forms the segment of a circle. The primrose has a leaf of this kind.



Fig. 19.  
OBTUSE.

An *obcordate* leaf—*folium obcordatum*—(fig. 20).—The Latin word *ob* is prefixed to technical terms, to indicate that a thing is inverted: *obcordate* means inversely *cordate* (see fig. 51), the notch being at the apex instead of the base of the leaf. Example: the *Oxalis acetosella*, sheep-sorrel.



Fig. 20.  
OBCORDATE.

An *emarginate* leaf—*folium emarginatum*—(fig. 21).—Emarginate (from the Latin, *e*, from, and *margo*, margin, or edge), notched. Having a notch at the end. Example: the *Geranium emarginatum*.



Fig. 21.  
EMARGINATE.

When the notch or sinus is very obtuse, it is said to be *retuse*, or *almost emarginate*.

A *lanceolate* leaf—*folium lanceolatum*—(fig. 22)—lance-shaped, as in the olive. Narrowly oblong and tapering to each end. The peach tree has leaves of this description.



Fig. 22.—LANCEOLATE.

An *acute* leaf—*folium acutum*—(fig. 23). Sharp pointed. Terminating in an acute point without tapering suddenly. The *Solidago odora*, an aromatic plant, is an instance.



Fig. 23.—ACUTE.

A *seta'ceo-acuminate* leaf—*folium setaceo-acuminatum*—(fig. 24).—(From the Latin, *seta*, a bristle.) The point of the leaf terminated by a straight bristle-like projection.

The *Quercus phellos*, willow-leaved oak, is an example. Leaves are



Fig. 24.—SETACEO-ACUMINATE.

*Mucronate* (from the Latin, *mucro*, in the genitive, *mucronis*, a sharp point), when an obtuse leaf terminates in a short, rigid point, formed by the projection of the midrib.

*Cuspidate* (from the Latin, *cuspis*, the point of a spear or other weapon), when it is more gradually prolonged into a rigid point.

*Pungent*, when it terminates in a hard sharp point, like the leaves of thistles.

**Awned** — *aristate* (from the Latin, *arista*, a beard of wheat), when it terminates in a long, hard bristle or beard.



Fig. 25. — ACUMINATE.

The *Cornus alternifolia* and reed are examples.

This figure (25) and the following (26) show the *primary nerves*, which arise directly from the petiole and midrib.

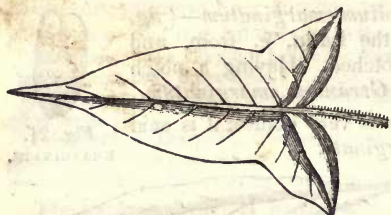


Fig. 26. — HASTATE.

This leaf is an instance of an angulinerve leaf.



Fig. 27. — SAGITTATE.

Example: *Polygonum sagittatum*, called tear-thumb, and turkey-seed.



Fig. 28. — PALMATO-LOBATE.

An *acuminate* leaf — *folium acuminatum* — (fig. 25). — (From the Latin, *acumen*, a point.) It has an extended termination, and in this respect differs from the lanceolate leaf.

A *hastate* leaf — *folium hastatum* — (fig. 26). — (From the Latin, *hasta*, a spear or halbert — halbert-shaped.) Triangular with lobes projecting perpendicularly to the petiole.

The *Polygonum hastatum* and bitter-sweet are examples.

A *sagittate* leaf — *folium sagittatum* — (fig. 27). — (From the Latin, *sagitta*, an arrow.) A leaf resembling the head of an arrow: the lobes at the base are

elongated, and scarcely diverging from the petiole. Example:

A *palmato-lobate* leaf — *folium palmato-lobatum* — (fig. 28). — (From the Latin, *palma*, palm of the hand.) Having lobes which give it some resemblance to the hand. This figure illustrates a palminerve leaf.

Example: — the *Liquidambar styracifera*, called sweet-gum.



A *palmate* leaf — *folium palmatum* — (fig. 29). Hand-shaped, divided nearly to the insertion of the petiole into oblong lobes of similar size, but leaving a space entire like the palm of the hand.

Examples: the *Viola palmata*, the passion flower, and castor-oil plant; also, the red and sugar maples.



Fig. 29. — PALMATE.

A *trilobate* leaf — *folium trilobatum* — (fig. 30). — (From the Latin, *tres*, three.) A leaf formed of three lobes, the margins of which are rounded.



Fig. 30. — TRILOBATE.

A *lyrate* leaf — *folium lyratum* — (fig. 31). — (From the Latin, *lyra*, a lyre.) A leaf supposed to resemble the shape of a lyre. It is cut into several transverse segments, gradually larger towards the extremity of the leaf, which is rounded, as in the *Salvia lyrata*, Lyre-leaved sage, and garden radish.



Fig. 31. — LYRATE.

A *sinuate*, or *sinuose* leaf — *folium sinuatum* — (fig. 32). A leaf having deep fissures or sinuses. Bending in and out. (*Sinus*: the bays or recesses formed by the lobes of leaves or other bodies, are so called.)

Example: the *Argemone mexicana*.



Fig. 32. — SINUATE.

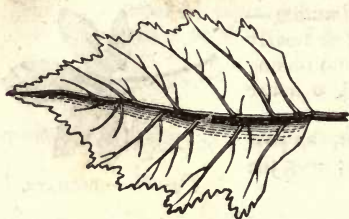


Fig. 33. — DOUBLY SERRATE.

A doubly serrate leaf—*folium duplicato-serratum*—(fig. 33).—(From the Latin, *serra*, a saw.) Having teeth like a saw: the larger teeth being notched also with teeth. (See fig. 48.)

Fig. 33 shows the secondary nerves arising from the primary.

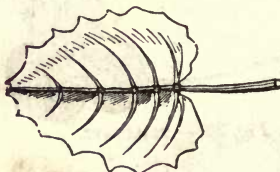


Fig. 34. — REPANDATE.

A repand leaf—*folium repandum*—(fig. 34).—(From the Latin, *repandus*, bent.) A leaf having a margin undulated, and unequally dilated, is so called.

Example: the *Hydrocotyle*.

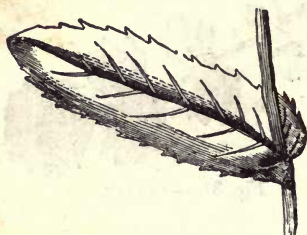


Fig. 35. — AMPLEXICAULE.

An amplexicaule leaf—*folium amplexicaule*—(figure 35).—(From the Latin, *amplecto*, I embrace, and *caulis*, stem, stem-embracing.) A leaf or bract whose base projects on each side, so as to clasp the stem with its lobes.

Example: the *Papaver somniferum*.

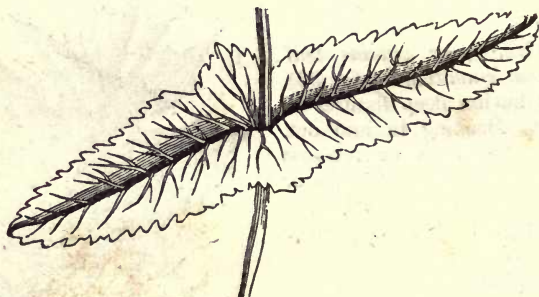


Fig. 36. — CONNATE.

A connate, or double-perfoliate, or doubly amplexicaule leaf—*folium connatum*—(fig. 36).—(From the Latin, *con*, together, and *natus*, grown.) Joined together at the base.

Example: the *Eupatorium perfoliatum*, bone-set.

A *perfoliate* leaf—*folium perfoliatum*—(fig. 37).—(From the Latin, *per*, through, and *folium*, leaf.) A leaf having the stem running through it. The annexed figure (37) is an illustration of a curvine leaf.

Example: the *Urularia perfoliata*, or bell-wort.



Fig. 37. — PERFOLIATE.

A *pandurate* leaf—*folium panduratum*—(fig. 38).—(From the Latin, *pandus*, bent or bowed inward in the middle.) Fiddle-shaped. It is also termed *panduriform*. It is oblong, broad at the two extremities, and contracted in the middle.



Fig. 38. — PANDURATE.

Example: *Convolvulus panduratus*, Virginia Bindweed, and *Convolvulus imperati*, native of Egypt, Italy, &c.

A *runcinate* leaf—*folium runcinatum*—(fig. 39).—(From the Latin, *run'cina*, a large saw, to saw timber.)



Fig. 39. — RUNCINATE.

Example: *Leontodon taraxacum*, common dandelion. (Dandelion, a corruption of the French, *dent de lion*, lion's tooth.)

An *undulate* leaf—*folium undulatum*—(figure 40).—(From the Latin, *undula*, a little wave.) Having the edges irregularly waved.

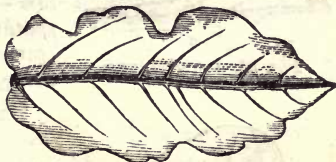


Fig. 40. — UNDULATE.

Example: *Asclepias obtusifolia*.

A *crenate* leaf—*folium crenatum*—(figure 41).—Having rounded teeth, which are not directed towards either extremity of the leaf, as in the garden pink, ground ivy, and heart's ease.

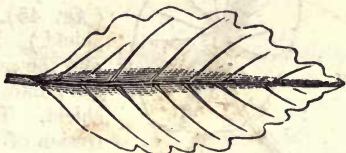


Fig. 41. — CRENATE.

*Crenulate*, finely crenate. Some leaves are doubly crenate, that is, bicrenate.

Example: the *Quercus prinus*, chestnut oak of Pennsylvania.



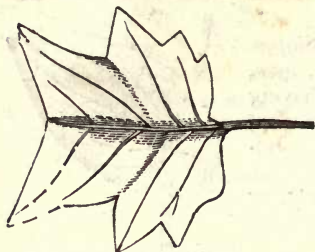


Fig. 42. — LOBATE.

A *lobate* leaf — *folium lobatum* — (fig. 42). — Divided more deeply than toothed or dentate, by somewhat obtuse incisions of an uncertain depth : each portion is termed a lobe. The number of lobes is sometimes specified.

Example: the *Liriodendron tulipifera*, or tulip tree; also called poplar, canoe-wood, sugar maple.



Fig. 43. — RENIFORM.

A *reniform* leaf — *folium reniforme* — (fig. 43). — (From the Latin, *ren*, kidney; and *forma*, form, shape.) Kidney-shaped. A short, broad, round leaf, with a sinus or hollow at the base.

This figure shows the tertiary nerves springing from the secondary.

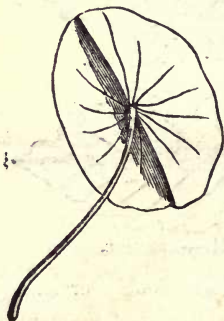
Example: the *Asarum canadense*, colt's foot.



Fig. 44. — SPATULATE.

A *spatulate* leaf — *folium spatulatum* — (fig. 44). — (From the Latin, *spathula*, a broad slice or knife to spread plasters.) Oblong or obversely ovate, with lower part much attenuated.

Example: the *Polygala lutea*.



A *peltate* leaf — *folium peltatum* — (fig. 45). — (From the Latin, *pelta*, a shield.) Where the petiole is inserted into the middle of the leaf on the under side, like the arm of a man holding a shield. This figure (45) is also an illustration of a *peltinerve* leaf.

Example: the common *nasturtium*.

Fig. 45. — PELTATE.

A *deltoid* leaf—*folium deltoides*—(fig. 48).—(From the Greek letter  $\Delta$ , *delta*, and *eidos*, resemblance.)

Example: the *Populus nigra*.

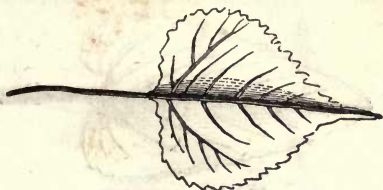


Fig. 46. — DELTOID.

A *dentate* leaf—*folium dentatum*—(fig. 47).—(From the Latin, *dens*, a tooth.) The edge having horizontal, distant teeth. This term, as well as the following, refers only to the edge or margin of the leaf, without regard to its general form.

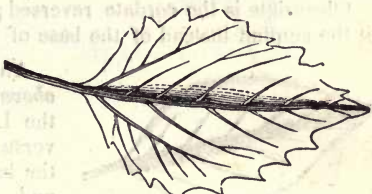


Fig. 47. — DENTATE.

Example: *Populus grandidentata*.

A *serrate* leaf—*folium serratum*—(fig. 48).—(From the Latin, *serra*, saw.) The edge being cut into notches, like saw teeth, ending in sharp points, which incline towards the apex of the leaf.



Fig. 48. — SERRATE.

The nettle, rose, and peach, are examples.

A *rhomboid* leaf—*folium rhomboideum*—(fig. 49).—Rhomb-shaped  $\diamond$ . A rhomb, in geometry, is a four-sided figure, having its opposite sides equal. When the angles are right angles, it becomes a square.

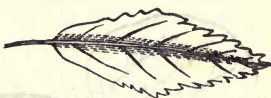


Fig. 49. — RHOMBOID.

An *auriculate*, or eared leaf—*folium auriculatum*—(fig. 50).—(From the Latin, *auricula*, a little ear.) It has two small rounded lobes, projecting at the base.

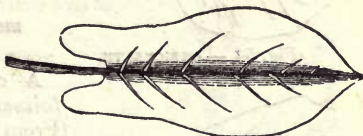


Fig. 50. — AURICULATE.

The *Magnolia auriculata* and *Rumex acetosella* are examples.

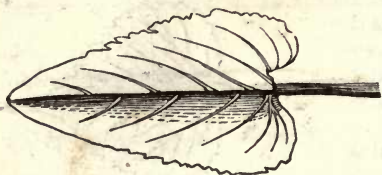


Fig. 51. — CORDATE.

Obcordate is the cordate reversed; the sinus and lobes being at the summit instead of the base of the leaf. (See fig. 20.)



Fig. 52. — OBOVATE.

An obovate leaf — *folium obovatum* — (fig. 52). — (From the Latin, *ovum*, egg.) The reverse of *ovate*, egg-shaped, with the base broader than the apex; and length greater than the breadth. (See fig. 20.)

Example: the *Arbutus uvi ursi*.

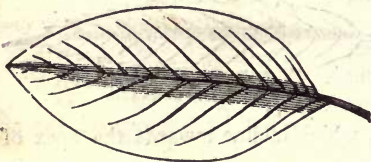


Fig. 53. — ELLIPTIC.

An elliptic or oval leaf — *folium ellipticum* — (fig. 53). — Having a regular outline, resembling an ellipse: the curves of both ends are alike, and it is longer than it is wide.

Example: the *Magnolia glauca*, common magnolia or beaver tree.

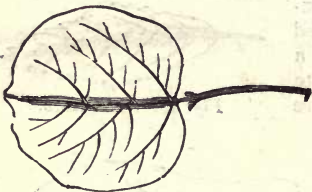


Fig. 54. — ORBICULATE.

An orbiculate leaf — *folium orbiculatum* — (figure 54). — (From the Latin, *orbis*, an orb.) Having a circular outline.

Example: the *Glycine tomentosa*.



Fig. 55. — CUNIFORM.

A cuneiform or cunieforn leaf — *folium cuniefornae* — (fig. 55). — (From the Latin, *cuneus*, a wedge.) Wedge-shaped. Broad and obtuse at the summit, and tapering gradually almost to a point at the base.

Example: the *Quercus nigra*, the true black oak or black jack.



A *partite* leaf — *folium partitum*, is one deeply divided nearly to the base, as *Helleborus viridis* : and according to the number of its divisions it is *bipartite*, *tripartite*, or *multipartite*.

A *multipartite* leaf — *folium multipartitum* — (figure 56). — (From the Latin, *multus*, many ; and *pars*, part—much divided.)

Having very deep and very distinct divisions.



Fig. 56. — MULTIPARTITE.

A *lacinate* leaf — *folium laciniatum* — (fig. 57). — (From the Latin, *lacinia*, a lappet ; a separate fold of a garment.) Divided by deep incisions ; the laciniae or parts being quite slender and numerous.

Examples : the *Dentaria laciniata*, and the *Rudbeckia laciniata*. Also, the lower leaves of the *Clematis flammula*, sweet virgin's bower.



Fig. 57. — LACINATE.

### EXAMPLES OF COMPOUND LEAVES.

Compound leaves may be referred to two classes or divisions ; one containing *digitate*, and the other *pinnate* leaves, accordingly as they are supposed to resemble fingers (*digitus*) or feathered stems (*pinnatus*). First, of digitate leaves :

A *conjugate* or *binate* leaf — (fig. 58). — (Conjugate, from the Latin, *conjugatum*, which is formed from *con*, together, and *jugum*, a yoke, yoked together. *Binate*, from the Latin, *bis*, two, and *natus*, grown.) When a common petiole bears two leaflets on its summit.



Fig. 58. — CONJUGATE.



Fig. 59.—TERNATE.

A *ternate* leaf—*folium ternatum*—(fig. 59).—(From the Latin, *ternus*, three and three.) When three leaflets arise from one petiole.

Example: the *Trifolium pratense*, red clover.

*Biternate*, twice three leaved: the petiole divided into three parts, and each part bearing three leaflets.

*Triternate*, three times three leaved: a common petiole divided into three parts, and each of these parts subdivided into three, and each subdivision bearing three leaflets, as in the wind flower.



Fig. 60.—TERNATE.

A *ternate* leaf, which is also doubly serrate (fig. 60), that is, *folium ternatum, foliis duplicato-serratis*,—a ternate leaf, with doubly serrate leaflets, as in Indian physic,—*Spiraea trifoliata*.



Fig. 61.—QUATERNATE.

A *quaternate* leaf—*folium quaternatum*—(fig. 61).—(From the Latin, *quater*, four.) Having four leaflets growing from a common petiole or leaf-stalk.

A *quinquefoliate* or *quinate* leaf—*folium quinquefoliatum*—(fig. 62).—(From the Latin, *quinque*, five, and *folium*, leaf.) Having five leaflets growing from one common petiole.

Example: ginseng—*Panax quinquefolium*.—*Panax* is derived from the Greek, *pan*, all, and *akos*, a remedy; a remedy for all things. It is an almost universal medicine among the Tartars and Chinese, and according to them, it is capable of relieving fatigue both of body and mind. It is a native of North America, where it is not esteemed as a medicine.



Fig. 62. — QUINQUEFOLIATE.

A *digitate* leaf—*folium digitatum*—(fig. 63),—composed of seven leaflets, an example of which is afforded in the perennial lupin, which is common in the neighborhood of Philadelphia.—(Digitate, from the Latin, *digitus*, a finger.) Compared to the spread fingers of a hand. When several leaflets arise from the very summit of the petiole, as in the horse-chestnut tree, and high blackberry.

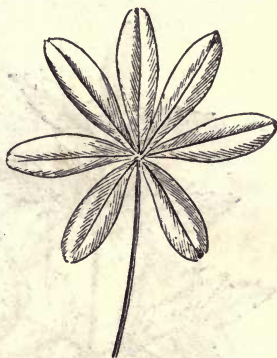


Fig. 63. — DIGITATE.

*The second division of compound leaves, called pinnate.*

A *pinnate* leaf—*folium pinnatum*—(fig. 64).—(From the Latin, *pinnatus*, winged or feathered.) Having leaflets arranged along each side of a common petiole, like the feather of a quill.



Fig. 64.  
PINNATE.





Fig. 65. — BIPINNATE.

A *bipinnate* leaf—*folium bipinnatum* — (fig. 65), — as that of the *mimosa farnesiana*. Doubly winged: a common petiole bearing pinnate leaves on each one of its sides. Most of the *Aca'cia* tribe have bipinnate leaves.

(Bipinnate: from the Latin, *bis*, two; and *pinna*, wing, —two-winged.)



Fig. 66. — BIPINNATE.

A *bipinnate* leaf—(fig. 66),—*folium bipinnatum*. We have an example of leaves of this kind in the Pride of China, — *Melia azederach*.

Here the leaflets of the secondary petiole are unequally pinnate. (See fig. 70.)



Fig. 67. — TRIPINNATE. — HEMLOCK.

A *tripinnate* leaf — *folium tripinnatum* — (fig. 67). — (From the Latin, *tres*, three; and *pinna*, wing.) *Conium maculatum*, — common hemlock. Common in many parts of the United States. When the common petiole has bipinnate leaves on each side.

A *pinnate* leaf, with *bijugate* leaves — (fig. 68). — *Folium pinnatum; foliolis bijugis* (from the Latin, *bis*, two; and *jugum*, yoke), formed of two pairs of leaflets, as seen in the *Cassia absus*, of India and Egypt.



Fig. 68. — PINNATE.

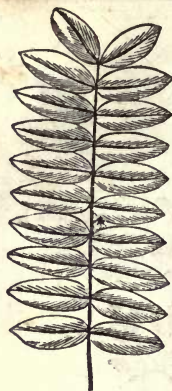


Fig. 69.

ABRUPTLY PINNATE.

An *abruptly pinnate* leaf (fig. 69). When the petiole of a winged leaf ends without a leaflet or tendril, as in the American senna, it is abruptly pinnate.

When the leaflets of the opposite sides alternate, it is *alternately pinnate*; and when the leaflets are alternately large and small, it is *interruptedly pinnate*.

When the leaflets are opposite or in pairs, as in the annexed figure (69), it is *oppositely pinnate*.



Fig. 70.—UNEQUALLY PINNATE.

An *unequally pinnate* leaf — *folium impari-pinnatum* — (fig. 70). Example: the shell-bark hickory.

When a pinnate or winged leaf is terminated by a single leaflet, as roses, &c., it is unequally pinnate, because the *pinnæ* or leaflets are not of an even or equal number.

When the leaflets are cut in fine divaricated segments, embracing the footstalk, we have the *verticillato-pinnate* leaf.

The *lyrato-pinnate*, “in a lyrate manner, having the terminal leaflet largest, and the rest gradually smaller, as they approach the base, like *Erysimum præcox*, and,

with intermediate smaller leaflets, *Geum rivale*; also, the common turnip.

“Such leaves are usually denominated lyrate in common with those properly so called (whose shape is simple, and not formed of separate leaflets); nor is this from inaccuracy in botanical writers. The reason is, that these two kinds of leaves, however



distinct in theory, are of all leaves most liable to run into each other, even on the same plant."—*Smith*.

A *cir'roso-pinnate* leaf—*folium cirroso-pinnatum* — (fig. 71). — (From the Latin, *cir'rus*, a tendril, a climber.)

Example: the tamarind tree, *Tamarindus Indica*.

In this form of leaf, a tendril supplies the place of the odd leaflet (as in the pea and vetch tribe), constituting the remarkable difference between it and the *unequally pinnate* leaf (fig. 70).



Fig. 71. — CIR'ROSO PINNATE.

A *pedate* leaf—*folium pedatum* — (fig. 72). — (From the Latin, *pes*, in the genitive case, *pedis*, foot.) A compound leaf, the divisions of which give it a resemblance to a foot with outspread toes. This is an example of the *pedalinerve* leaf (see page 39), in which there is no decided midrib, but the vessels diverge in two strong lateral nerves, from which branches are given off, on that side only which is towards the apex of the leaf.

Example: the *Helleborus fætidus*.



Fig. 72. — PEDATE.



Fig. 73. — PEDATE.

A *pedate* leaf, with compound leaflets — *folium pedatum* ; — *foliis compositis*.

Example: the Maiden hair — *Adiantum pedatum*. A very common plant in the neighbourhood of Philadelphia.



Fig. 74. — LEAVES OF PITCHER PLANTS.

The most singular of all the various leaves, are those of the *pitcher plants*. The pitcher of the *Nepenthes* (74, c) is provided with a perfect lid or cover, which is closed in dry weather, as if to prevent evaporation, and open when it is rainy or damp. It has been suggested, that these *pitchers* were designed as reservoirs in which water is stored for the occasional use of the plant in extremely dry weather.

When the petiole becomes dilated and hollowed out at its upper end, the lamina being articulated with and closing up its orifice, as in *Sarracenia* (fig. 74, a), and *Nepenthes* (fig. 74, c), it is called a *pitcher*, or *ascidium* ; if it is enclosed and is a mere sac, as in *Utricularia* (fig. 74, b), it is called *ampulla*.

The surface of a leaf may be *ribbed* or *nerved*, having fine elevations, running from one extremity to the other, without branching ; or

*Veined*, having prominent divisions near the base, and finer and smaller as they extend over the leaf, as in the mullein ; or

*Wrinkled, rugose, rough, or corrugated*, like the leaf of the sage ; or

*Plicate* (plaited), having the surface formed into ridges and channels, by the alternate rising and sinking of the nerves of the leaf; or

*Smooth*, when without wrinkles or ribs; or

*Villose*, or *velvety*, when covered by soft down or hairs.

Besides the general form, the character of the margin, and surface of leaves, their position is also described. When upright, and the leaf forms a very acute angle with the stem, it is *erect*. When they are at right angles with the stems, and parallel with the horizon, they are *horizontal*. When the apex of the leaf hangs lower than the insertion of the petiole, it is *reclined*. When the base of the leaf is turned in one direction, and the apex in another, that is, twisted, it is *oblique*.

*Radical* leaves are those which grow very near to the root.

When leaves arise one after the other from opposite sides of the stem, they are *alternate*; but when they arise, on the same line, from opposite sides of the stem, they are *opposite*.

When they grow in a circle round a stem, they are *verticillate* (whorled) or *stellate*.

## EXHALATION.

30. When treating of absorption, we saw that vascular plants pump up, by their roots, a considerable quantity of water, holding different matters in solution, and that this liquid rises through the stem to reach the leaves. But all the water thus absorbed does not remain in the interior of the plant, and a great part is dissipated in the form of vapour. To satisfy ourselves on this point, it is only necessary to place in a perfectly dry glass jar, the leafy stem of a vegetating plant, and expose the whole to the sun; we soon discover little drops which arrange themselves on the parietes of the jar. By weighing plants immediately after they have been watered, and weighing them again some time afterwards, we obtain proof of this loss, and we may exactly estimate the quantity of water exhaled; it was found, by an experiment of this kind, that a cabbage lost by evaporation nineteen ounces of water a day, and a helianthus (from the Greek, *elios*, the sun, and *anthos*, flower) or sunflower loses even a more considerable quantity in form of vapour.

31. A small part of the water thus expelled, evaporates through the tissue which constitutes the surface of all parts of the plant, as well after death as during life; and it is for this reason that the stem, fruit, tubercles, and flowers terminate their existence by drying, when the place in which they may be is not very damp. But the greatest quantity of water is expelled through the leaves of the living plant, and this exhalation only takes place, while the plant is alive, and when the influence of light

30. What becomes of the water absorbed by the roots? How is it ascertained that plants exhale water in form of vapour? What quantity of water does a cabbage exhale?

31. What parts of plants are seats of exhalation? When does exhalation take place? What influences exhalation? What description of plants exhale least?



causes the stomata to open. It has been ascertained that the quantity of water thus exhaled is in proportion to the extent of the leafy surface of the plant, and the number of stomata ; thus, fleshy plants, which have but few stomata, lose very little by aqueous exhalation.

32. Light, as we have said, has the property of causing the stomata to open, but these orifices close when the plant is placed in the dark. During the night, plants lose very little by evaporation ; and it is known that the best way of preserving a bouquet as fresh as possible, is to put it in an obscure place, or at least shelter it from the light of the sun.

33. Exhalation is more active in dry warm air, than when the atmosphere is cold and damp ; and it takes place more actively in young leaves, than in those of which the surface has been hardened by age. The water that thus escapes is almost pure, and it is estimated that, under ordinary circumstances, it is equal to about two-thirds of the quantity of liquid absorbed by the roots. Sometimes this exhalation becomes even more abundant than absorption, and causes the death of the plant ; this often happens when we transplant a tree in spring, without taking sufficient care to lop the branches, for by taking it from the earth we destroy a great many radicles of the root, and absorption is consequently less active ; in order to proportion the exhalation to this enfeebled absorption, gardeners leave but a small number of leaves on the summit of the stem.

### RESPIRATION.

34. Plants cannot live when deprived of air, and are, just as much as animals, under the necessity of constant respiration ; but their respiration is carried on in a different manner from that of animals.

35. All parts of the plant, root, stem, and flowers, as well as the leaves, continually absorb a certain quantity of oxygen from the air, which combines with the carbonous particles of the sap, and thus forms carbonic acid ; but this carbonic acid is not expelled as in animals, but serves for nutrition.

[Before we proceed further, let us endeavour to obtain clear notions of the meaning of the words *oxygen* and *carbonic acid*.

32. Why are we recommended to put a bouquet in the dark for preservation ?

33. What condition of the atmosphere is most favourable to exhalation ? What is the character of the water exhaled by plants ? What happens if exhalation is greater than absorption ? Why do gardeners carefully lop trees that are transplanted ?

34. Do plants breathe ?

35. What parts of plants absorb oxygen ? What becomes of the oxygen absorbed ? What is the use of carbonic acid to plants ?

The air we breathe (called atmospheric air) is a compound of about one part of *ox'ygen* gas to four parts of *ni'trogen* gas, and a very much smaller proportion of *carbo'nic* acid gas, together with some watery vapour.

Ox'ygen and ni'trogen are simple substances, that is, chemists have not been able to decompose them; but carbonic acid gas is a compound substance, that is, it consists of more than one material or substance.

This name, *ox'ygen*, is formed from the Greek, *oxus*, acid, and *geinomai*, I beget, and was so called because it was believed, without it, there could be no acid. Although there are acids which contain no ox'ygen, we know that without its presence every living thing, animal or plant, would die, and all fire would be extinguished. It is indispensable to respiration and combustion.

The word *ni'trogen* was formed from the Greek, *nitron*, nitre, and *geinomai*, I beget, because it was discovered to be one of the essential constituents of nitre, and also of nitric acid. It was also called *azote* (from *a*, privative, and *zoe*, life), because it would not support animal life.

*Carbo'nic acid* consists of *carbon* and *ox'ygen*.

*Carbon* (from the Latin, *carbo*, coal) is the name of a simple substance or element. It occurs naturally in the form of the diamond (which is pure carbon), of *plumbago* or *black-lead*, anthracite and bituminous coals; it is an elementary constituent of all wood; it seems to be the true food of plants, without which they die. *Lamp-black* and charcoal are forms of impure carbon. The chief action of vegetable organization is to obtain and form carbon.

*Carbo'nic acid* exists in the atmosphere as the product of combustion, and of the respiration of animals; the frothing of beer, and the sparkling of champagne and "mineral water," depend on its presence.]

36. The leaves and other green parts of plants also absorb the carbonic acid gas contained in the air, and by the process of respiration, this fluid, as well as the carbonic acid formed in the interior of the plant, is decomposed; its carbon remains in the tissue of the plant, and nourishes it, while the oxygen is thrown off and mingles with the atmosphere.

37. We now see that the relations of plants with the air are more complicated than those of animals with the same fluid. The latter absorb oxygen, and in its place exhale carbo'nic acid; plants absorb ox'ygen and carbo'nic acid, and exhale the ox'ygen arising either from the quantity of this gas previously absorbed, or from the decomposition of the carbo'nic acid derived from the atmosphere.

38. In general it is the last phenomenon, that is, the absorption of carbonic acid, its decomposition and the exhalation of ox'ygen, that is designated under the name of *respiration of plants*. Its effect, as we see, is to destroy the carbo'nic acid,

36. What parts of plants absorb carbo'nic acid gas from the atmospheric air? What becomes of the constituent elements of the carbo'nic acid of plants?

37. How does the respiration of animals differ from that of plants?

38. What constitutes the respiration of plants? What is the effect of the respiration of plants? How does it purify the atmosphere?

which the respiration of animals is unceasingly diffusing through the air, and consequently to purify the atmosphere.

39. The green parts alone possess the property of decomposing carbo'nic acid in this way, and they cannot effect this decomposition without the direct influence of the light of the sun. Thus, a plant which is put in an obscure place ceases to respire, languishes, bleaches, and dies, after a shorter or longer time.

40. Consequently, the leaves are the principal seat of respiration, and this function is only carried on during the day.

41. It is easy to demonstrate the influence of light upon the respiration of plants; a simple experiment is sufficient to do this: if we place leaves in water containing a small quantity of carbo'nic acid in solution, and expose them to the sun, we see bubbles of air rise from them; but if we place them in the shade, this disengagement of gas is arrested.

42. In leaves exposed to the air, the absorption of carbo'nic acid takes place chiefly through the stomata, and this fluid acts upon the sap in the interior of the cavities which exist in the paren'chyma of the leaf, and abandons its carbon to pass to the state of free ox'ygen. The intercellular passages (meatus) of the leaves consequently perform, in the respiration of plants, functions analogous to those of the pulmonary cells in terrestrial animals; and it is remarkable that in aquatic plants, the leaves of which are submerged, there are no similar cavities, and respiration is carried on by the surface of the leaves, just in the same manner as the skin or projecting branchiæ perform this function in aquatic animals.

43. During the night, the leaves, instead of purifying the air, absorb ox'ygen, and consequently contribute towards its vitiation. For this reason, as well as on account of the odour they exhale, it is often dangerous to place plants or even bouquets of flowers in sleeping apartments.

44. The absorption of ox'ygen by the parts of plants that are not green is feeble, but takes place by day as well as by night, and it is necessary to the life of all plants. It is because roots do not obtain the air which they require that they die, when too deeply buried; and it is for the same reason that a seed will not germinate when removed from the action of the atmosphere.

39. Do all parts of a plant decompose carbo'nic acid? Do plants decompose carbo'nic acid under all circumstances?

40. Do plants respire at all times?

41. How is it shown that light influences the respiration of plants?

42. In what part of the plant does the carbo'nic acid act on the sap? What is remarkable in the respiration of aquatic plants?

43. Why is it improper to keep plants in apartments in which we sleep?

44. Why do roots and seeds die when too deeply buried?



## OF THE USE AND MODE OF DISTRIBUTION OF THE NUTRITIVE JUICES.

45. The sap elaborated in the leaves, as we have seen, again descends to other parts of the plant, and constitutes the nutritive juice by the aid of which its growth is effected.

46. It is easy to be convinced that the nutritive juices of plants are formed in the leaves; for if we strip a tree of all its leaves, it will cease to grow until it is furnished anew with these organs; and farmers who cultivate mulberries for feeding silkworms have remarked that the growth of the trees is less in proportion to the frequency of stripping them of their leaves.

47. The movement of the nutritive juice (that is, the *descending* sap) is slow, and always takes place from the leaves, towards the roots, whatever may be the position of the branches that this liquid traverses.

48. The route followed by the descending sap is not the same as that by which the sap rises from the roots to the leaves; instead of traversing the ligneous layers, it descends chiefly through the substance of the bark.

49. The following experiment proves that it is the descending sap which especially serves for the nutrition of the plant, and that this same sap moves in the interior of the bark. If we remove from a branch or the trunk of an exogenous tree, a circular strip of bark, we prevent the sap that descends from the leaves to the lower part of the plant from continuing its route, and, in fact, we see that the portion of the stem which is below this annular or ring-like section, ceases to grow, while the part situate above profits more than is usual, and swells out on the upper margin of the wound, so as to form a ring. The same thing happens when we surround a branch by a very tightly drawn cord; for in this way we may also arrest the descending sap, and the parts where this juice accumulates are benefited at the expense of those situated below.

45. What becomes of the sap that is elaborated in the leaves? (Elaborate: from the Latin, *labora're*, to work. The word is employed to signify the act of living organs upon substances capable of assimilation, by which nutritive matter is separated and appropriated. The *elaboration* of food in the stomach produces *chyme*.)

46. What proof is there that the nutritive juice of plants is formed in the leaves?

47. Is the movement of the nutritive juice rapid? In what direction does it flow?

48. What is the route of the descending sap?

49. How do you prove that the descending sap is the nutritive juice of plants, and that it moves through the substance of the bark?

50. For this reason gardeners sometimes make annular incisions through the whole thickness of the bark around a branch filled with fruit, so as to retain the nutritive juice, and augment the size of the fruit.

51. The greater part of the descending sap is found, as we have before stated, in the bark; but it appears that this liquid also traverses the young layers of the albur'num, and it is by its action that we explain the transformation of this albur'num into perfect wood or dura'men. (Dura'men: Latin, hardening.)

52. The descending sap appears to be chiefly composed of water holding gum and some other substances in solution. It must be regarded as the chief source from which the plant derives the materials composing; 1st, the excreted products; 2d, the peculiar juices secreted in the different organs and designed to remain in the interior of the plant; 3d, the new tissues. We shall now study these phenomena successively in order.

#### OF SECRETIONS.

53. Plants, as well as animals, form, in certain parts of their bodies, peculiar liquids, which differ from the generally diffused juices; and it is to the process by which these peculiar liquids are formed, as well as to the liquids themselves, that we give the name of *secretion*.\*

54. The matters secreted may be thrown out or expelled, or they may be destined to remain in the interior of the plant, and subserve the purposes of nutrition or some other function.

55. The matters that plants excrete in this way are very various. A great many plants produce in reservoirs, situate near the external surface, volatile oils that evaporate through their tissue and diffuse themselves through the air; the odour of flowers and also of certain leaves depends in a great measure upon this exhalation; and it is to an emanation of this kind that is due

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\* Secretion: from the Latin, *secer'nere*, to separate. The process by which organic structure is enabled to separate, from the fluids circulating in it, other different fluids. The function of secretion is usually performed by glands, and each gland secretes a peculiar fluid according to its structure; for example, the liver *secretes* bile, that is, it separates from the blood circulating in the liver, the materials which it forms into bile; the salivary glands secrete *saliva*, and the mammary glands in females, *secrete* milk, &c. Now, *bile*, *saliva*, and *milk*, are also termed secretions.

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50. How may the size of fruit be augmented?

51. Does the descending sap pass through any other part than the bark?

52. What are the chief uses of the descending sap?

53. What is meant by the term secretion?

54. What becomes of the secretions?

55. Mention some of the various secretions of plants.

a singular phenomenon presented by a plant named *Fraxinella*, which in hot days exhales an essential oil in such abundance, that if it be approached with a light, the vapour with which the plant is surrounded takes fire and burns, like that we force out of an orange or lemon skin by pressure, into the flame of a candle. Other plants secrete a caustic juice, which is frequently poured out through hollow hairs, and thus produces a lively irritation at the bottom of punctures made by these hairs. The nettle is an example of this kind. Again we have wax secreted by the leaves or epidermis of young branches and afterwards expelled; and we have also produced in this way gluey, acid, saline, sugary, and other secretions.

56. These excretions\* are formed by the roots as well as by the leaves; and as the matters thus expelled are of a nature that is injurious to the plants which produce them, we understand through the knowledge of this fact why plants of the same species do not flourish when kept for a long time in the same soil; for the matters expelled by the roots are deposited in the earth surrounding them, and are again absorbed by the plants growing in it. But the matters expelled by one plant may often be suitable nourishment for a plant of another species, and it is for this reason that the ground often becomes fitted for certain culture when it has been previously made to produce plants in which the excretion by the roots is abundant. The art of *assolement* or succession of crops, so important in agriculture, is chiefly based upon the results depending on this excretion by the roots. We give the name of *assolement* to the succession in the same soil of different crops, combined in such a manner as to produce as largely as possible; and we say triennial, quaternial *assolement*, &c., according as the cultivation of the same plant recurs every three, every four years, &c.

57. The liquids secreted by plants and designed to remain in the interior of their organs are designated under the name of *proper juices*; if they escape externally, it is altogether by accident, and their production appears to be useful to the health of the plant that forms them. These juices are sometimes milky,

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\*[Excretion: from the Latin *excer'nere*, to separate from. The throwing off those matters which are supposed to be useless or injurious to organic life, as the perspiration in animals. An excretion is a secretion that is thrown out of a plant or animal because useless to its internal well-being.]

56. Do other parts than the leaves of plants form excretions? Why is it that farmers do not plant the same plant in the same field, year after year? What is meant by excretion?

57. What are proper juices? What are their characters?



sometimes resinous, sometimes composed of essential oils, and at other times formed of fatty matters.

58. The milky juices are chiefly found in the bark, and appear to constitute the liquid we see circulating in the vessels of the *latex*, in a great number of plants. The white liquid that runs from the fig tree when it is cut, opium, caoutchouc (India rubber), &c., are juices belonging to this class.

59. The resinous juices are very common in the bark, and are also met with in other parts of the stem; they are formed in little masses which become united together, and descend by their own weight in the tissue of the plant. Sometimes these juices are so abundant that, by making an incision in a tree, we cause a stream to flow out of it, and in this way collect considerable quantities of its proper juices; as we see in pine and fir trees.

60. The essential or volatile oils are contained in cells or vesicles, and are found in the foliaceous and cortical parts of plants. And the proper juices constituted of fatty oils are chiefly found in the seeds.

61. The solid matter, found in the elongated cells of the wood, and on this account called *lignin* (from the Latin, *lignum*, wood), may also be considered as being the product of a species of secretion, as well as the *fecula*, which is produced in great abundance in certain parts of plants, seemingly forming deposits of nutritive matter, destined at a future time for the nourishment of the plant. This last substance has the appearance of small, white, hard grains, which seem to be composed of different layers, the exterior of which are hardest, and the most internal are similar to gum. It is found isolated in the cells of the cellular tissue; and in some parts of certain plants, such as the seeds of wheat or of rye, the tubers of the potatoe, the ligneous stems of monocotyledonous plants, &c., it forms considerable masses.

## OF THE GROWTH OF PLANTS.

62. The growth of plants depends upon two phenomena: 1st, the increase of the diameter of stems already formed; 2d, the development and elongation of new branches. We will successively examine both.

58 Where are the milky juices found? Give some instances of milky juices.

59. How are resinous juices collected from plants? In what part of the plant are they found?

60. In what parts of plants do we find the essential oils? In what part the fatty oils?

61. What is lignin? What is fecula? Where is it found?

62. Upon what does the growth of plants depend?

63. The cellular tissue of plants, while it is still young, and receives a sufficient quantity of nutritious juices, gives rise to new cells, which are at first very small, isolated and soft; but which, in proportion as they are developed, enlarge and harden, and become as closely united to each other as to the cellular tissue upon the surface of which they are formed. Those cells which have ceased to grow, no longer possess the power of giving rise in this way to new tissue; they become strongly joined to the young cells with which they are in contact; and hence it is that the growth of plants takes place only from the surface of the most recently formed parts.

64. In ex'ogenous plants, the new tissue is thus deposited between the albur'num and the bark, and at first appears in the form of a viscid matter which is called *cam'bium*. Those tissues which arise from the albur'num, form around the ligneous body or wood of the stem, a new layer of albur'num, exterior to all those that have been already deposited; and those which arise from the bark constitute a new cortical layer, within the layers of bark already formed. Each of these layers increases in thickness for a certain time, then ceases to grow, and, at the end of a certain period, in its turn produces a new layer.

65. Perennial ex'ogenous plants in this way form a new layer of wood and of bark every year; and if we cut through the stem of a tree transversely, we may see the number of zones or rings of which it is composed, and thus count the number of years it has lived.

66. The thickness of these layers varies in different plants, and also varies in the same tree according to its age, the richness of the soil in which it grows, and the abundance of its leaves, &c. Trees grow most rapidly during the first years of their existence, and it is observed that in old trees the most external ligneous layers are thinnest. When the soil that surrounds the foot of a tree is more favourable to vegetation on one side than on the other, the roots become unequally developed, and on the side where the largest roots are found are also found the largest branches and the thickest ligneous layers.

67. The new ligneous and cortical layers are not restricted to covering the surface of the plant, but are prolonged beyond it, and, at different points, form lateral expansions which constitute

63. From what parts does the growth of plants take place?

64. What is *cam'bium*? How is the new matter deposited? Do the new layers always continue to grow?

65. How long is occupied in the formation of a new layer?

66. Is the thickness of these layers the same in all plants? When is the growth of trees most rapid?

67. What are buds? Where are they found? What are the characters of these buds? Upon what does the rapidity of their growth depend?

the new branches. These young shoots are, in general, protected in their first growth by peculiar scales, and then constitute what are called *buds*. They are ordinarily found at the base of the petioles of the leaves, or at the extremity of the branches in ligneous plants, and at the *collum* or neck of the root in perennial herbaceous plants. Sometimes they are not apparent externally, and are concealed even in the substance of the wood: but in most instances they have the form of a small projecting tubercle, which shows itself in the summer, and is known to farmers under the name of *eye*; during the winter they enlarge, and in the spring, when the sap begins to rise with strength, and to carry towards the extremity of the branches the nutritive matters previously deposited in the roots or in the stem, they rapidly develop themselves, their scales separate, and we see a young branch spring from them, the leaves of which are at first variously plaited and very close together; this new shoot grows more rapidly in proportion to the abundance of the sap, and during a certain time is elongated throughout its length. But after the first year it ceases to grow in this way, and it then forms laterally, and particularly towards its upper part, new layers of vegetable tissue which contribute to the increase of the length of its extremity, and, at the same time, to augment the diameter of its base.

68. In en'dogenous trees growth takes place very nearly in the same manner, only the new parts do not form concentric layers, but simply bundles (*fasciculi*) of fibres variously arranged, and the buds are ordinarily developed at the extremity of the stem and branches.

69. We have said above that the cells of the cellular tissue, when very young, tend to become united or soldered to each other. This is so true that if we lay bare a portion of new tissue of two neighbouring trees, and bring these parts together and keep them in contact, they become so intimately united that the two soon form a single body, and possess one life in common. The art of *grafting* plants depends upon a knowledge of this fact.

[Grafting is an operation by which one plant is joined to another in vital union, in such a manner as to form one. The tree upon which grafting is practised is called the stock, and the branch, or rudiment of a branch that is fitted to it, is named the graft. The stock is ordinarily a wild shrub, and the graft a cultivated variety of the same plant. In order to succeed, the albur num of the graft must accurately fit, through the greatest part of its extent, that of the stock, that is, the tree upon which the graft is implanted; then the junction, or, as it were, soldering of the two barks, is

68. How does the growth of en'dogens differ from that of ex'ogens?

69. Upon what does the art of grafting depend? What is grafting? What are the modes of performing this operation?



effected by the assistance of the cambium. One condition necessary to the success of the operation is, that the sap of the two plants shall be similar; for example, the plants of the same genus, or of the same family, are more readily grafted upon each other than those which belong to different families. Grafting is a very useful operation in agriculture; it serves to preserve and multiply varieties which could not be produced by means of seeds; it saves time by procuring a great number of trees which are with difficulty multiplied by other means, and accelerates by many years the fructification of certain plants.

Gardeners employ five or six different processes to obtain the development of the bud or graft upon the bark of other trees which they use as stocks.

*Splice or whip grafting*, consists in paring down in a slanting direction both the graft and stock, and, after applying them neatly to each other, securing them by strands of bast matting, in the same manner as two pieces of rod are spliced together to form a whip handle. The part is afterwards covered with tempered clay, or any convenient composition that will exclude the air.

*Grafting by approach, or inarching*, is a mode of grafting in which, to make sure of success, the graft or scion is not separated from the parent plant until it has become united to the stock.]

70. Such are the principal phenomena of the life of nutrition in plants: but they are far from taking place with the same intensity at all times; and their duration is extremely variable.

71. In every plant we observe periods of activity, of languor, and even torpor, and then an augmentation of the vegetative functions. In our climate these periods correspond with the four seasons of the year. During winter, the cold and absence of the leaves, in most plants, almost entirely arrests nutrition; they are then in a state of torpor, comparable to that which hibernating animals experience, and their buds and roots alone continue to grow. But when returning spring imparts to the plant thus benumbed a certain amount of heat and moisture, it awakes in a measure, the sap rises with force, the buds develop themselves, the young shoots or scions become elongated, and vegetation displays all its activity. In summer the leaves are somewhat hardened, and become less suited for attracting the sap and exhaling the liquids which reach them from the roots; consequently vegetation is less active: and in autumn this change in the leaves being greater, gradually brings about their destruction or fall. At this period, it sometimes happens that buds begin to develop themselves, and again attract the sap with force; and this ascent of the nutritive juices causes an elongation of the branches and the formation of new leaves, the freshness of which is in beautiful contrast with the yellow tint of the old ones. But the cold soon enfeebles all these phenomena of life, and arrests

70. Is the duration of all plants the same?

71. Are the functions of vegetables always equally active? How is their activity influenced?

nutrition, even when it does not cause the fall of the leaves, as ordinarily happens.

72. In hot countries, where there is no winter properly speaking, there are, nevertheless, periods of activity and repose in plants which correspond to the dry and wet or rainy season; there the great heat arrests vegetation as the cold does in our climate, and the life of plants is reanimated in the rainy season.

73. As we have already stated, a great number of plants are *annual*, that is, they live only through one year; others complete their growth only in the second year, and die on the approach of the second winter, and are termed *biennial*; others again continue to live many years, and are for this reason called *perennial* plants. All herbaceous plants are *annual* or *biennial*; ligneous plants live many years, and the duration of their lives exceeds every thing we could imagine. One of the orange trees at Versailles, in France, appears to be nearly four hundred years old; and a tree of the same species, which may be still seen at the convent of Saint Sabin in Rome, was planted there by Saint Dominick more than six hundred years ago. In Switzerland there are linden trees which, to judge from their diameter and the manner in which these trees ordinarily grow, ought to be more than a thousand years old; and there is a chestnut tree at Sancerre, which was known six hundred years ago as the *great* chestnut, from which we may conclude that its age is not much less than that of the lindens we have just mentioned. But the tree most celebrated on account of its longevity is, unquestionably, the *baobab*, that flourishes in Senegal. A botanist named Adanson notices one which three centuries before had been observed by two English travellers, and on excavating the trunk of this tree, there was found an inscription they had written, covered by three hundred ligneous layers; from this they were enabled to judge how much this gigantic plant had grown in three hundred years, and, comparing this with the diameter of the tree, it was estimated that the probable duration of its existence was upwards of five thousand years.

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72. Is there any variation in the activity of the functions of vegetables in hot countries?

73. What is meant by an annual plant? What is meant by a biennial plant? What is a perennial plant? What is supposed to be the age of the oldest living tree?

## LESSON IV.

GENERATION OF PLANTS.—*Multiplication of Plants by Division*—*Formation of adventitious Roots*—*Multiplication of Plants by Grafting*; *by Tubercles*—*Phanerogamous and Cryptogamous Plants defined*—*Structure of Flowers*—*Peduncles*—*Pedicil*—*Floral Leaf*—*Bract*—*Involucre*—*Spathe*—*Glume*—*Torus*—*Receptacle*—*Inflorescence*—*Perianth*—*Calyx*—*Corolla*—*Petals*—*Forms of the Corolla*—*Nectary*—*Æstivation*—*Essential Parts of Flowers*—*Stamens*—*Anther*—*Pollen*—*Pistil*—*Carpel*—*Ovary*.

## OF THE REPRODUCTION OF PLANTS.

1. The multiplication of plants takes place in two ways; sometimes by means of special organs, designed to produce the germ of the new individual, and sometimes by the simple division of their tissue.

2. The *multiplication of plants by division* consists in the separation of a part of an individual, which part continues to vegetate, and becomes so complete in itself as to constitute, in its turn, a new individual plant.

3. This phenomenon depends upon the fact that the different parts of a plant, placed under favourable circumstances, have a tendency to produce those organs which are wanting to constitute a complete plant, and that the portion which gives rise to these complementary parts becomes fit to live without the assistance of the individual from which it was taken. For example, a branch placed in favourable circumstances may put forth roots (which are called *adventitious* when they arise in this way, as before stated in page 19), so that, if it be separated from its stem, it will still continue to be nourished, and will constitute a new individual; the same is true of roots; they also have the faculty of giving rise to stems and to leaves; and a root from which a stem and leaves arise possesses all the organs necessary for vegetation, and consequently may continue to live after it has been separated from the plant of which it at first formed a part.

4. Gardeners give the name of *shoots* or *slips* to those branches from which they cause adventitious roots to spring, and which they then separate from the parent plant. In general we succeed

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1. How is the multiplication of plants effected?
  2. What is meant by the multiplication of plants by division?
  3. Upon what does the multiplication of plants by division depend?
  4. How are adventitious roots artificially produced?



in producing these roots by placing in a properly moist situation, a branch in which the progress of the descending sap is slow, therefore permitting an accumulation of nutritive matter in it. To arrest in this way the descending sap at a point from which we wish to produce adventitious roots, we sometimes make a circular incision through the thickness of the bark, and place in it a tightly drawn ligature, and then surround it with moist earth; sometimes we simply bend a branch into the ground, because, at the point where it is bent, the nutritive juices, being forced to overcome their own weight in order to ascend towards the stem, are retarded in their progress; at other times we take advantage of natural knots that exist in a branch and favour the development of adventitious roots; and there are some plants, the branches of which, when surrounded by moist earth or moss, put forth roots without a stagnation of the nutritious juices being necessary. When the roots appear, we cut the branch so as to separate it from the plant to which it belonged, and it then constitutes a new individual.

5. But we do not separate the slip or branch until the roots are formed, that is, when it possesses all the parts that compose a complete plant; but it often happens that a branch cut before it has put forth adventitious roots, continues to vegetate and produce roots so as to constitute a new individual: for example, a branch of willow freshly cut and planted in moist earth, promptly takes root and becomes a tree similar to that from which it was detached; it is then called a slip or sucker. All plants may be multiplied in this way, but with more or less facility; as this operation rarely succeeds, gardeners seldom have recourse to it.

6. It is not the branches alone that may give rise to adventitious roots and constitute a slip or shoot; sometimes the leaves will perform this office; for example, the leaves of the orange, of the fig, &c., detached from their stems and fixed in the earth by their petiole, will take root by their principal nerve, and afterwards give rise, from the superior surface of their paren'chyma, to ascending stems.

7. The *multiplication of plants by grafting*, of which we have already spoken, is also a mode of propagation that belongs to this class of phenomena, because it is effected by simple division; only the part of the plant which is separated, instead of

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5. When is the new branch separated?

6. Do any other parts than branches produce adventitious roots? (See page 19.)

7. What is the multiplication of plants by grafting?

becoming complete in itself, forms an intimate union with another plant, and lives at the expense of its roots as a sort of parasite.

8. *Propagation by tubercles* is another mode of multiplication by division, which is effected by means of buds surrounded by a deposite of nutritive matter, which, being placed in favourable circumstances in regard to moisture, heat, &c., may vegetate and put forth a stem and roots. These deposites of nutritive matter are sometimes formed in the roots, sometimes in subterraneous stems, sometimes in the axil\* of the leaves, ordinarily designated under the name of *tubercles*, *off-sets*, which, when they have attained a certain size, are usually detached. The potatoe presents us with a remarkable example of this mode of multiplication; this plant produces along its stems tubercles which are not developed ordinarily except in its subterraneous part, and are only held by a thin thread, so as to be easily separated at the end of the year, either by the slightest force, or from the death of the stem from which they grow; now, each one of these tubercles has upon it several buds or germs (called *eyes*) enveloped by a mass of cellular tissue containing fecula, &c.; if placed in a situation that is sufficiently moist and warm, these buds soon begin to sprout and attract the nutritive matters deposited around them; by means of this nourishment the bud elongates, the stem and leaves begin to develop themselves, and as soon as they begin to perform their ordinary functions, the nutritive juices, prepared within them, descend and cause the formation of roots so as to give rise to a new and complete plant.

9. To recapitulate: we see, then, that, under certain favourable circumstances, all plants may be multiplied by division, and that this division may be effected by shoots, by slips, by grafting, and by tubercles; but in most cases, the reproduction of plants is effected in a manner altogether different, by the means of seeds, which are themselves the production of particular organs: namely, flowers and fruits.

10. The special organs destined to secure the multiplication of plants are the flowers, fruits, and seeds.

11. Plants that are provided with perfectly distinct flowers, are designated under the name of *Phanero'gamous* (from the Greek, *phaneros*, evident, and *gamos*, marriage); and those which have no distinct special organs of multiplication are called *Crypto'*-

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\* Axil: from the Latin, *axilla*, arm-pit. The angle or point at which a leaf or branch unites with the stem.

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8. What is meant by the propagation of plants by tubercles?
  9. How is the reproduction of plants usually effected?
  10. What are the special organs of reproduction of plants?
  11. What are phanero'gamous plants? What are crypto'gamous plants?

*gamous* (from the Greek, *kruptos*, concealed, and *gamos*, marriage).

12. The *flower* consists of the assemblage of organs, upon which spring the germs of phanero'gamous plants, and the parts which immediately surround them. Its use is to secure the production of these germs, and their fecundation (fertilization), that is, to endow them with the faculty of living and of developing themselves so as to be able to become plants, similar to those from which they were derived.

13. The *fruit* is the assemblage of these germs already fecundated, and of organs destined to protect them until they attain maturity, that is, the state of perfect seeds.

14. And the *seed* is the germ furnished with various envelopes, that is, the body which, by its development, becomes the new plant, and the organs designed to protect it, or to furnish the young plant its first nourishment.

### *Of the Structure of Flowers.*

15. The flowers, as we have stated above, are the parts in which the germ of the new plant is produced and acquires the property of living and of developing itself. They are composed of appendages analogous to leaves, but of various forms, which arise from the extremity of the stem or its ramifications.

16. Sometimes the flowers arise immediately from the stem without being attached to it by a tail or any accessory part; in this case they are termed *sessile* (from the Latin, *sessilis*, dwarfish, that is, without a stalk or stem); but in general that portion of the stem which bears them is prolonged and constitutes a sort of tail, analogous to the petiole of a leaf; to this support we give the name of *peduncle* (from the Latin, *pes*, a foot,) a little foot,—(figs. 81, 82, 96); and when it is divided, each one of the divisions that is terminated by a flower is called a *pedicil*. (See fig. 1, page 11).

17. For example: *pedunculate flowers* have the tail or stem simple, as in the common pink; and *pedicelate flowers* have several tails springing from one common to the whole, as in bunches or clusters of lilac, of the vine, &c.

18. The peduncle or the pedicil of a flower may arise from

12. Of what does the flower consist? What is its use?

13. What is meant by the fruit?

14. What is the seed?

15. Of what are flowers composed?

16. What is the peduncle of a flower? What is a pedicil?

17. What is meant by pedicelate flowers?

18. What is a floral leaf? What is a bract?



the very extremity of the branch that bears it, or laterally, and in this last case, it arises from the axil of a leaf, which on this account has been called *floral leaf*, when it resembles other leaves (*fig. 86*), and is named *bract* (from the Latin, *bractea*, a thin leaf of metal), when it differs from the other leaves in its colour, its form (*figs. 75 and 76*), or in the absence alone of the buds in its axil.

19. These *bracts* may be found at the base of the peduncle, or at the base of each of its divisions, when this support is ramified as in pedicelate flowers. When they are symmetrically arranged around one or several flowers, so as to form a kind of accessory envelope, the assemblage is called an *involucre* — from the Latin, *involutus*, folded in (*fig. 75*). — Generally, they have a foliaceous consistence, but they sometimes resemble little scales, more or less closely embracing the base of the flower. When the involucre surrounds a single flower, and is very close to it, it often resembles one of the proper envelopes of the flower, called *calyx* (Latin, the cup of a flower), and in this case it is commonly known under the name of *calicula*, as in the mallow. When the involucre entirely covers a flower before it is blown, and the flower is not seen externally until this envelope



*Fig. 75. — INVOLUCRE.*



*Fig. 76. — SPATHE.*



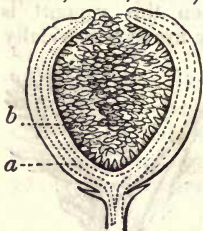
*Fig. 77. — GLUME.*

is torn open or unrolled, it is called a *spathe* (*fig. 76, sp*, from the Greek, *spathe*, a ladle): — the common onion, narcissus (*fig*

113), the palm, &c., are examples. Finally, the *bracts* of some plants are in the form of two small scales, which seem to be in the place of the proper envelopes of the flower, and then they constitute what botanists call *glume* (from the Latin, *gluma*, a husk of corn, *fig. 77*).

20. The terminal portion of the pedicil which gives rise to the different parts of the flower, is called *torus* (from the Latin, *torus*, a bed).

When the terminal extremity of a peduncle is divided into a great number of pedicils, and these are very short, we generally remark that the principal support is widened and thickened, and to this dilated portion of the peduncle we give the name of *receptacle*; it contains a deposit of nutritive matter destined to assist in the development of the flowers situate above, and it is sometimes entirely fleshy as in the artichoke; sometimes it is so concave as to completely enclose the flowers and fruits that arise from it, as is seen in the fig tree (*fig. 78*).



*Fig. 78.*—RECEPTACLE.

completely enclose the flowers and fruits that arise from it, as is seen in the fig tree (*fig. 78*).

21. We give the name of *inflorescence* to the arrangement which the flowers assume on the stem, and we give special names to the different arrangements they assume. For instance, those flowers which spring from the axil of an ordinary leaf, are called *axillary flowers*; and these axillary flowers are again distinguished by the terms *solitary*, *geminal*, *ternary*, *quaternary*, and *fascicular*, according as one, two, three, four, or a greater number spring from the axil of the same leaf: and we give the name of *verticillate* to flowers which arise from the axil of leaves which are also verticillate, and form a kind of ring around the stem. *Terminal* flowers are those found at the extremity of the stem or a principal branch, and accompanied at their base by two opposite bracts; the term *spike* (*fig. 79*) is applied to axillary flowers which are arranged upon a common, but simple and not ramified axis, as in the wheat, &c.; when unisexual flowers furnished with scales, the known peduncle of which is similar to that of the spike, but is articulated at its base in such a manner

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*Explanation of Fig. 78.*—Flowers of a fig tree enclosed in a concave receptacle;—*a*, receptacle;—*b*, flowers.

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20. What is meant by torus? What is the receptacle?

21. What is meant by inflorescence? What is meant by axillary flowers? What are verticillate flowers? What are terminal flowers? What is a spike? What is a cat-kin? What is a cluster? What is a panicle? What is a thyrus? What is a corymb? What is an umbel? What is a capital?

as to be entirely detached after inflorescence, as, for example, in the flowers of the willow, elm, beech, oak, &c., it is called a *catkin*; when all the flowers are borne upon a common peduncle,

irregularly branched, they are termed a *cluster*, as in the horse-chestnut; when flowers are arranged on the stem similarly to a cluster, but have the secondary divisions very much elongated and widely separated from each other, they form a *panicle*, as in the male flowers of the maize or Indian corn; *thyrsus* is a sort of cluster, the axis of which is much elongated, and the branches of which, in particular, have the same

arrangement as the assemblage of the cluster, as in the lilac and vine; a *corymb* is where all the flowers, the peduncles of which with their ramifications arise from the upper part of the stem, at different points, and reach to nearly the same height, as in the milfoil; when the peduncles



Fig. 79.  
A SPIKE.



Fig. 80. — A CAPITAL.

are of equal lengths and arise from the same point, diverging and ramifying in a uniform manner so that the assemblage of flowers presents an arched surface like the top of an extended parasol, we have an *umbel*, as in the carrot, parsley, hemlock, &c. (fig. 156); we give the name of *capital* to an assemblage of a considerable number of little flowers upon a common receptacle, that is wider than the summit of the peduncle, and surrounded by a particular involucre, as in the artichoke, milk-thistle (fig. 80), the marigold (fig. 153), the sunflower, &c.; *capitals* are often designated under the name of *compound* or *composite* flowers, because at first sight the assemblage of all the flowers borne upon a common peduncle appear to form only one and the same flower.

22. The *flower* itself is ordinarily composed of two series of organs, namely, (1.) the essential parts, which occupy the centre,



and, (2.) the accessory or tegumentary parts, which occupy the circumference, and serve to protect the first.

23. These *tegumentary parts of the flower* constitute what is called the *perianth* (from the Greek *peri*, around, and *anthos*, flower); sometimes they are wanting entirely; and at others they are imperfect; but in most instances they form around the essential organs of inflorescence two envelopes, the most external of which is called the *calyx* (cup of the flower), and the second, which is situate above, and within the preceding, is named the *corolla* (from the Latin, *corolla*, a little crown)—(figs. 81, 82, 83, 84).

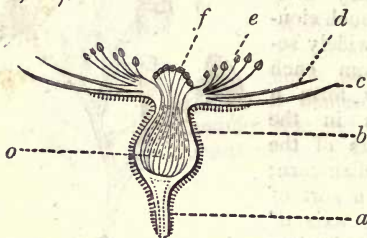


Fig. 81. — SECTION OF A FLOWER.

24. **CALYX.** The calyx or the external envelope of the flower is composed of a variable number of appendages, analogous to leaves, which are called *se'pals*; they are arranged nearly in a circle around the inferior part of the flower (fig. 81, b, c). Their colour is generally green;

their surface is furnished with stomata, and their structure is similar to that of leaves.

25. Sometimes all the se'pals are perfectly distinct and may be separated without breaking their tissue; in this case they constitute a *polyse'palous\** calyx; at other times they are joined, or as it were glued together, in such a way that the calyx appears to be formed of a single piece, and is then designated under the name of *monose'palous†* or *gamose'palous‡* calyx (figs. 84, 89, 95). When this junction extends throughout the whole extent

*Explanation of Fig. 81.*—Vertical section of a polypetalous flower (of the family of Rosaceæ), showing the relative position of its different parts:—a, the peduncle;—b, the calyx;—c, division of the calyx;—d, the corolla;—e, the stamens;—f, the stigma;—o, the ovary.

\* **POLYSE'PALOUS.**—From the Greek, *polus*, many, and se'pal—having many sepals.

† **MONOSE'PALOUS.**—From the Greek *monos*, single, and se'pal—having a single se'pal.

‡ **GAMOSE'PALOUS.**—From the Greek *gamos*, marriage, and se'pal—having the se'pals united together, forming a single piece or sepal.

23. What is a perianth?

24. What is a calyx?

25. What are sepals? What is a polyse'palous calyx? What is a monosepalous calyx? What is meant by an entire calyx? What are the lobes of the calyx? What is a regular calyx? What is an irregular calyx? What is a labiate calyx?

of the se'pals, the calyx is entire, but in general it occurs only at the base, and then the terminal and free portion of the se'pals constitutes the *lobes* or *teeth* which occupy the upper part of the calyx and spread more or less. We give the name of *tube* to the lower and commonly contracted part of a calyx thus formed, and the superior and open part is called the *limb*. In most dicotyledonous plants, the calyx is composed of five se'pals, and when these appendages are united at the base, presents five lobes; sometimes, however, there are only three or even two, and there are examples of a considerably greater number. Its form varies: sometimes it is *regular*, that is, composed of parts entirely like each other; sometimes *irregular*, that is, consisting of parts that differ from each other in form or size. Sometimes certain se'pals are united to each other for a shorter distance than the rest, so as to form divisions of unequal size, and constitute what botanists term a *labiate calyx* (*labiate*, from the Latin *labium*, lip).

26. The se'pals, like the leaves, are sometimes *caducous* (from the Latin *cado*, I fall), and sometimes *persistent* (from the Latin *per*, through, and *sisto*, I remain); after inflorescence they sometimes dry where they are, and at other times, on the contrary, they enlarge and become fleshy. Their form varies: some are *lanceolate* (lance-shaped) or pointed, others are blunt, and others again are *cordiform* (heart-shaped). In some plants their extremity is hardened so as to resemble a spine or a long hair.

27. The whole of the calyx formed by the assemblage of the se'pals also presents considerable differences; the *monosepalous calices* may be *tubular* (or elongated in the form of a tube, as in the pink); *urceolate* (from the Latin *urceus*, a pitcher), or in form of a pitcher or urn, contracted above the limb and then dilated, as in the rose; *campanulate* (from the Latin *campanula*, a little bell), or in form of a bell; *vesicular*, *compressed*, *angular*, &c. The *polysepalous calices* also vary; some are *tubular*, others are *campanulate*, others *stellate* (star-shaped), &c.

28. *Corolla*. The internal envelope of the flower or *corolla* is composed, like the calyx, by the union of a certain number of lamellar appendages somewhat analogous to leaves, which are arranged circularly in one or more rows or whorls (*figs. 82, 83, 84*). To these appendages we give the name

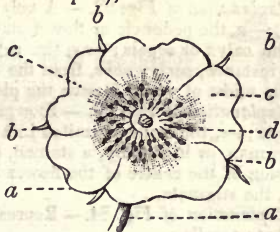


Fig. 82. — COROLLA.

26. In what particulars do se'pals resemble leaves?

27. What are the forms of calices?

28. What is a corolla? What are petals?

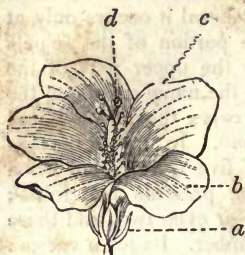


Fig. 83.

## POLYPETALOUS COROLLA.

of petals (from the Greek *petalon*, a leaf, fig. 83, c), and it is to be observed that they differ from leaves more than the sepals; they have but few stomata; their nerves, which are similar to those of the leaves as regards their direction, are more slender, and contain no other kind of vessels but tracheæ; they are very seldom green, but generally possess the most brilliant colours.

29. The corolla is sometimes *monopetalous* or *gamopetalous* (fig. 84), that is, composed of a single piece, formed by the intimate union of all the petals (as in the flower of the bind-weed); at other times it is *polypetalous* (figs. 82, 83), that is, composed of a greater or less number of separate petals (as in the rose, pink, &c.). The number of petals is ordinarily five, in which case they are arranged around the essential organs of the flower in a single row or whorl or verticellus; sometimes there are three or four only, or seven, and at other times a much larger number, and then they are placed so as to form several concentric whorls (verticelli), and to alternate with those of the neighbouring row. Polypetalous flowers are called *dipetalous* when they have two petals only; *tripetalous* when they have three; *tetrapetalous*, *pentapetalous*, *hexapetalous*, when they have four, five, and six petals, and so on.



Fig. 84.

## MONOPETALOUS COROLLA.

30. We generally recognise in a petal, the *claw* or inferior part, corresponding to the petiole of the leaf, which is more or less contracted, and the *limb*, which is more or less spread and

*Explanation of Fig. 82.* — A polypetalous flower (of the family of Rosaceæ):—a, the peduncle or flower-stalk;—b,b,b,b, extremities of the divisions of the calyx or sepals;—c,c, the petals of the corolla;—d, the stamens (in this instance, *perigynous*, from the Greek, *peri*, around, and *gune*, woman), in the midst of which is seen the pistil.

*Explanation of Fig. 83.* — Flower of a malva'cea:—a, the calyx;—b, the corolla;—c, the stamens united in a tubular andro'phorum (from the Greek *aner*, man, or in Botany, a stamen, and *pherein*, to bear) — a columnar expansion of the centre of the flower upon which the stamens seem to grow:—d, the stigmata.

*Explanation of Fig. 84.* — Represents a monopetalous, labiate flower, or bilobate corolla.

29. What is meant by a monopetalous corolla? What is a polypetalous corolla?

30. What is the claw of a petal? What is the limb of a petal? What is the throat of a corolla?



constitutes the upper part. Its form varies very much; sometimes it is *rounded*, sometimes *acute*, sometimes *hollow*, and at other times its base is prolonged like a spur. Like the calyx, the *corolla* is sometimes *regular*, sometimes *irregular*; sometimes it is *cadu'cous*; that is, it falls as soon as it is expanded or blown; at other times it fades in the flower before it is detached, and is then said to be *marcescent*, and we generally distinguish an inferior, straight portion, which, in monopetalous flowers, constitutes the *tube*; a superior part which is more or less flaring, called *limb*, and a circular line which separates the latter from the tube, and bears the name of *throat*.

The general form of the corolla varies much; the following are its principal modifications.

### VARIETIES OF THE COROLLA.

Corollas are *monope'talous*, when they are formed of a single petal, and *polype'talous*, when they consist of several petals.

MONOPETALOUS COROLLAS are either *regular* or *irregular*.

31. The principal forms of REGULAR MONOPETALOUS COROLLAS, are the following:

*Tubular*, when the tube is long, as in the lily.

*Campanulate*, or bell-shaped, as in the annexed figure (85). (From the Latin, *campana*, a bell.) Example: the campanula.

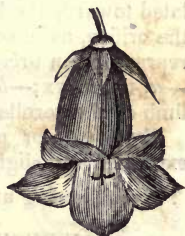


Fig. 85.—CAMPANULATE.

*Infundibular*, or funnel-shaped, as in the flower of the tobacco (fig. 86).

(Infundibular, from the Latin, *infundibulum*, a funnel.)



Fig. 86.

INFUNDIBULAR.

31. What is a tubular corolla? When is it campanulate? When is it infundibular? When is it cyathiform? What is a hypocrate'rifform corolla? What is a rotate corolla? What is an urce'olate corolla? What is a scu'tellate corolla?

*Cyathiform*, or cup-shaped (*fig. 87*). (*Cyathiform*, from the Latin, *cyathus*, a drinking-cup.) It differs from the infundibular corolla in having its tube, and of course its border, less spreading; and from the campanulate, in not having its tube appear as if scooped out at the base.



Fig. 87.

CYATHIFORM.



Fig. 88.

PRIMROSE.

*Hypocrate'riform*, or salver-shaped, when the tube is long, and expanded into a flat limb at the throat or entrance into the corolla, as in the primrose.

(*Hypocrate'riform*: from the Greek, *upo*, under, *krater*, cup, and *phorme*, shape. Salver-shaped.) The form of a corolla consisting of a tube, suddenly expanded into a flat border. (*Fig. 88*:—*c*, corolla;—*d*, the calyx.)

*Rotate*, or wheel-shaped, when the tube is very short, and the limb expanded and almost flat.

*Urceolate*, or pitcher-shaped, when it is dilated towards the base, and contracted towards the orifice, as in several heaths, &c. *Fig. 89* represents an urceolate, monopetalous corolla:—*a*, the calyx;—*b*, tube of the corolla;—*c*, the limb of the corolla;—*d*, the pistil.

*Scu'tellate*, or porringer-shaped, when it is expanded and slightly concave, like a basin.

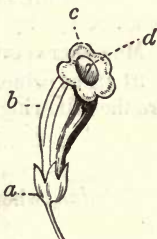


Fig. 89.

URCEOLATE.

The following are the principal forms of

### IRREGULAR MONOPETALOUS COROLLAS.

32. *Bilabiate*, when it is more or less elongated, dilated, and open towards the top, and terminated by two lips, one superior and the other inferior (*fig. 90*).

*Personate*, or in form of a mask, when the tube is elongated and the throat dilated and closed above by the approximation of the limb, which consists of two unequal lips (*fig. 91*).

*Anomalous*, when its form is so irregular that it cannot be referred to any of the ordinary types.



Fig. 90.

BILABIATE.



Fig. 91.

PERSONATE  
COROLLA.

32. What is a bilabiate corolla? When is a corolla personate? When

The following are the principal forms of

### REGULAR POLYPETALOUS COROLLAS.



Fig. 92.—CRUCIFORM.

*Cruciform* (from the Latin, *crux*, a cross), when it is composed of four petals with an elongated claw, arranged in the form of a cross, as in cresses (*fig. 92*).

(The four petals have the form of a St. Andrew's cross; the lower part is the unguis or claw, and the upper part is called the tolamen or border, each petal having the form of a battledore. The claw is somewhat longer than the border.)

*Rosa'ceous*, when the petals, from three to five, or more, have a very short claw, and are expanded as in the simple rose (*fig. 93*).

*Caryophylla'ceous* (from the Latin, *caryophyllus*, the garden pink)—when the petals, five in number, have very long claws, concealed by the calyx, as in the pink.



Fig. 93.

The following are the principal forms of the

### IRREGULAR POLYPETALOUS COROLLAS.

*Papiliona'ceous* (from the Latin, *papilio*, a butterfly), when the petals, five in number, have each a peculiar form, the two lower ones ordinarily united to each other, forming what is called the *carina* or *keel* (*fig. 95*); the two lateral ones are generally expanded and called wings; and the superior one ordinarily erect, various in form, and covered by the other four, previous to the



Fig. 95.  
CARINA.

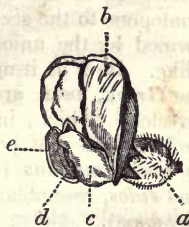


Fig. 94.—PEA.

*Explanation of Fig. 94.*—Represents a papiliona'ceous flower;—*a*, the calyx;—*b*, the banner;—*c*, the wings;—*d*, the carina or keel;—*e*, the stamens.

*Fig. 95* is the same flower, having the banner and wings removed to show the carina.

is it anomalous? What is a cruciform corolla? What is a rosaceous corolla? When is it caryophylla'ceous?

33. What is a papiliona'ceous flower? What is the vexillum?



blowing of the flower, and called the *banner*, or *standard*, or *vexillum*, as in the pea, acacia, &c. (*fig. 94*).

*Anomalous*, when the petals are irregular without having the papilionaceous form, as in the violet.

34. **NECTARY.**—The word “nectary,” (from nectar, the food of the gods,) is of very general application, and is used to express some peculiar modifications in the sepals or petals, by which they assume an unusual form; but more especially when there is some alteration of structure, by which they are wholly or partially converted into secreting organs, and exude a saccharine, glutinous juice.



*Fig. 96.* — NECTARY.

35. **ÆSTIVATION.**—As the condition of the leaf whilst yet in bud, is termed its *vernation*, so the manner in which the several parts of the flower lie folded in the flower-bud, is termed their *æstivation*.

36. Certain flowers (the tulip for example), instead of having a double perianth, have only a single envelope, and we are not certain whether it is a calyx or corolla. In general it seems to bear a closer resemblance in structure to the calyx, but it sometimes presents the bright colours of corollas; it is sometimes analogous to the first of these floral envelopes, and sometimes analogous to the second; and at other times again it is entirely formed by the union of the two, which have become perfectly alike. Be it as it may, we give the name of *perigonium* (from the Greek, *peri*, around, and *geinomai*, I grow) to this single envelope (which, in other respects, may be double or simple); and flowers that possess this mode of organization are termed *monochla'mydous* (from the Greek, *monos*, one, *chlamus*, cloak, and *eidos*, resemblance:—apparently having but one covering or envelope).

37. **ESSENTIAL PARTS OF FLOWERS.**—The essential parts of a flower occupy its centre (*figs. 81, 82, 83*), as has been stated above, and, although they are the most important, they are very

*Explanation of Fig. 96.* — Flower of the larkspur; — *n*, the nectary; — *p*, the peduncle.

34. What is meant by nectary?

35. What is meant by vernation? (Vernation: from the Latin, *vernus*, belonging to the spring.) What is æstivation? (Æstivation: from the Latin, *æstiva*, summer quarters.)

36. What is the perigonium? What are monochla'mydous flowers?

37. What are the essential parts of flowers?

far from being the most apparent to the eye. These organs are of two kinds; one kind is destined to produce the ovules or germs, and the other to cause their fecundation; the first bears the name of *pistil*, and the second is called *stamen*.

38. Most flowers are provided both with a *pistil*, and with *stamens*, and consequently possess all the organs necessary for the production and fecundation of germs; they are distinguished by the name of *hermaphrodite flowers*. Others, on the contrary, either possess only stamens (*fig. 97*) or a pistil alone (*fig. 98*), and are named *unisexual*; the plants that bear these incomplete flowers are termed *monœceous* (from the Greek, *monos*, single, and *oikos*, a house), when the two kinds of flowers, those with pistils, and those with stamens, are developed on the same plant; but when these different flowers grow on separate plants, some producing flowers with stamens, and others bearing flowers with pistils only, they are named *diœceous* (from the Greek, *dis*, two, and *oikos*, house). Those which have flowers provided with all the organs are named *polygamous* plants.



Fig. 98.  
PISTIL.



Fig. 97.  
STAMENS.

39. *Stamens*.—The stamens are situate between the corolla (*d*) and the pistil (*f*) (*fig. 99, e*); they are generally in form of filaments (threads), and in no manner resemble the leaves in their use; nevertheless, they may be considered as analogous to leaves, because, under certain circumstances, they are changed into petals.

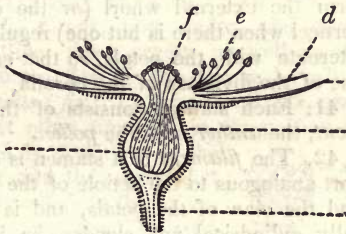


Fig. 99.

In double flowers, for example, it is by the stamens being changed into petals that the corolla, in place of being simple, as in the natural or uncultivated state, presents a greater or less number of whorls.

*Explanation of Fig. 97.*—Represents (enlarged) one of the male flowers of a fig tree, isolated; it has three stamens, each one crowned by an anther.

*Fig. 98.*—Represents (enlarged) one of the female flowers of the fig tree, separated; it shows a pistil.

38. What are monœceous flowers? What are diœceous flowers? What are polygamous flowers?

39. Where are the stamens situated? How are stamens analogous to leaves? What are double flowers?

40. The number of stamens varies much in different plants; certain flowers which are on this account named *monandrous* (from the Greek, *monos*, single, and *aner*, stamen), have but one stamen; other flowers called *diandrous* (fig. 101), *triandrous*, *tetrandrous*, *pentandrous*, &c. (fig. 100) have two, three, four, five, or more stamens. In general, their number is equal to that of the petals, or is a multiple of the petals. Sometimes they are all



Fig. 100.  
PENTANDROUS.



Fig. 101.  
DIANDROUS.

alike, and at other times they are not of the same size; when the same flower always has two short and two long stamens, it is named *didyna'mous* (from the Greek, *dis*, twice, and *dunamis*, power); when the whole number of stamens is six, and four of them are longer than the other two, the plant is termed *tetradyna'mous* (from the Greek, *teteres*, four, and *dunamis*, power). These organs form one or more whorls or verticels, situate within the corolla (fig. 102), and in general those which form the external whorl (or the only verticel when there is but one) regularly alternate with the petals, so that each stamen corresponds with one of the divisions of the corolla.



Fig. 102.

41. Each stamen consists of three parts: namely, the *filament*, the *anther*, and the *pollen*.

42. The *filament* of a stamen is a support analogous to the petiole of the leaves and the claw of the petals, and is generally cylindrical and slender, as in fig. 103, *b*. Sometimes it is so short that it seems to be wanting, and in this case, the stamen is said to be *sessile*; generally, however, it is very long.

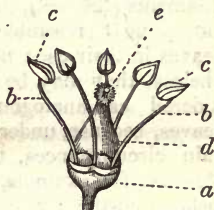


Fig. 103. — STAMENS.

43. The filaments arise from the

*Explanation of Fig. 103.*—A flower without its envelopes;—*a*, the calyx;—*b*, the filament of the stamen;—*c*, the anthers;—*d*, the ovary;—*e*, the stigma.

40. Have all flowers the same number of stamens? What is a didyna'mous flower? What is a tetradyna'mous flower? How are sta'mens placed in respect to the petals?

41. Of what parts does each stamen consist?

42. What is the filament? When is a stamen said to be sessile?

43. What part gives rise to the filament? Are the filaments joined together, or are they separate from each other? What is an androphor?



torus or receptacle (*fig. 104, c*), that is, from the superior extremity of the pedicel of the flower, between the corolla and the pistil (*figs. 103 and 104*). Generally they are distinct from each other, and entirely free, but sometimes they are joined together, and in this way form one or more bodies, to which we give the name of *androphor* (from the Greek, *andros*, the genitive of *aner*, man, *anther*, and *phoreo*, I support—*anther-bearer*:—*fig. 105*).

In certain plants, such as the mallows, this cohesion takes place between the filaments of all the stamens, so that the *androphor* constitutes a tube of greater or less length, in the interior of which the pistil is lodged (*fig. 110, p. 81*). At other times the stamens are united in two or more bundles (*fasciculi*) and then form two or more *androphors*. And there are flowers in which the anthers cohere to each other, although the filaments are distinct (*fig. 105, a*).

44. The point where the stamens cease to adhere to the neighbouring parts varies; sometimes they arise below the portion of the pistil called the ovary (*figure 104*); they are then termed *hypogynous* (from the Greek, *upo*, under, and *gune*, woman or pistil); at other times these organs, as well as the petals, seem to arise at a greater or less distance above the calyx, and are then termed *perigynous* (*fig. 81*) (from the Greek, *peri*, around, and *gune*, pistil). At other times again, the portion of the pedicle which bears them is prolonged in the same way between the calyx and the ovary, but adheres to the latter organ as well as to the calyx, and in this instance the stamens seem to arise above the ovary, and are named *epigynous* (from the Greek *epi*, upon, and *gune*, woman or pistil). *Fig. 106*:—*o*, the ovary;—*e*, the stamens;—*s*, the stigma.

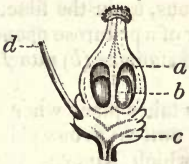
45. In consequence of these differences, the stamens may have four different and fixed positions:

*Explanation of Fig. 104.*—A vertical section of the same flower, to show the interior of the ovary;—*a*, the lodges or cells of the ovary;—*b*, the ovules;—*c*, the torus or receptacle;—*d*, filament of the stamen.

*Fig. 105.*—A flower opened to show the coherence of the stamens by the anthers (*a*) while the filaments are distinct.

44. What is meant by a hypogynous stamen? What is meant by a perigynous stamen? What is meant by an epigynous stamen?

45. What are the several positions of the stamens?



*Fig. 104.*



*Fig. 105.*



*Fig. 106.*

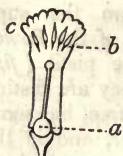


Fig. 107.

1st. *Upon the internal parietes of the tube of the corolla*, when it is monopetalous, as in the lilac.—*Fig. 107* represents the flower of a primrose opened, showing the pistil (*a*) and the stamens (*b*) attached to the corolla (*c*).

2d. *Upon the ovary*, which takes place when the corolla is *epipe'talous*, as in *umbelliferous* plants.

3d. *Beneath the ovary*, which happens when the corolla is *hypope'talous*, as in the *poppy*, the *cruci'fera*, the *vine* (*fig. 115*), &c.

4th. *Upon the calyx*, which always occurs when the calyx bears the petals, as in the rose (*fig. 82*).

46. The corolla always has the same position as the stamens; in all monopetalous corollas, the stamens are attached to the corolla, and in all polype'talous flowers the stamens are not attached to the corolla.

47. *Anther*. The anther is the most essential part of the stamen, and occupies its summit (*fig. 103, c*); its colour is almost always yellow, and it may be compared to the limb of a very small leaf, that has become thickened, narrow, and folded upon itself. In its interior the pollen is formed; and it ordinarily consists of two small membranous sacks, named cells or lodges, which are joined together back to back, or by a portion of the superior extremity of the filament, called the *connective*. Sometimes there is but one of these cells, which seems to be owing to the abortion of one of these pouches, or to the bifurcation of the filament; and at other times there are four. There are some also that are divided internally by partitions. The form and mode of insertion of the anthers vary; sometimes these organs are elongated, at other times rounded, cordiform, &c. Sometimes they adhere to the filament for a great part of their length; at other times they are attached by one of their extremities only, and at other times again, they are fixed at their middle upon the very extremity of the filament.

48. *Pollen*. The pollen is a yellow dust that is enclosed in the cells of the anther, which by falling upon the pistil causes the development of germs and the formation of seeds. It is composed of extremely small grains, the surface of which is sometimes smooth, sometimes covered by asperities, and their interior is filled with extremely fine dust. The envelope of these grains of pollen is composed of two membranes, and when they come to be

46. Where are the stamens attached in monopetalous flowers? Where are they attached in polypetalous flowers?

47. Describe the anther. What is meant by the connective? Is the form of all anthers the same? Are their attachments alike in all flowers?

48. What is pollen? Where is it formed? What is the use of it?

moistened, the internal vesicle swells, tears the external membrane, and escapes, forming species of tubes of greater or less length.

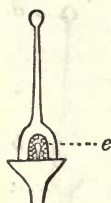


Fig. 108.  
PISTIL.

49. *Pistil*. The pistil (*figs. 108, 109*), or organ that produces the germ, occupies the centre of the flower, and is surrounded by the stamens, by the perianth (*figs. 103, 110*). The portion of the torus or extremity of the pedicel where it springs sometimes takes its rise above the origin of other parts of the flower, so as to form for this organ a special support, named a *gymnophore* (from the Greek, *gumnos*, naked, and *phoreo*, I support). The pistil is composed of appendages, named *carpels*, which are somewhat analogous to leaves, but they are folded inwards, and bear on their edges the ovules destined to become seeds (*fig. 110*).



Fig. 109.  
PISTIL.

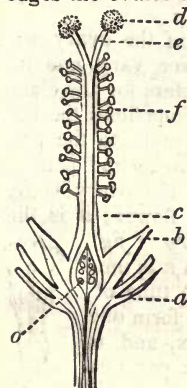


Fig. 110.—PISTIL.

50. In each carpel we distinguish three parts: the ovary (*fig. 110, o*), the style (*e*), and the stigma (*d*). The *ovary* occupies its lower part and encloses a cavity or cell (*fig. 108, e*), in which the germs are developed. The *style* (*fig. 111, c*), is a superior prolongation of the ovary, which is, however, much less, and is often even as slender as a thread; it varies extremely in length. And the *stigma* (*fig. 110, d*), is the terminal portion of the pistil which surmounts the style; or, when this latter organ is wanting, it rests on the ovary, and is generally composed of a soft and, to appearance, glandular tissue.

51. The number of carpels varies much; sometimes there is only one, sometimes two or three, or even more, and, as we have seen in the case of sepals and petals, these organs cohere more or less

*Explanation of Fig. 108.* — Pistil, with the ovary (*e*) opened.

*Explanation of Fig. 109.* — Pistil of the jasmine magnified.

*Explanation of Fig. 110.* — Vertical section of a polypetalous flower, showing the manner in which the *androphor* sheaths the pistil:—*a*, the calyx;—*b*, the corolla;—*c*, the androphor open;—*f*, the anthers;—*d*, the stigmas;—*e*, the styles, the upper portion of which is free and the lower part adherent;—*o*, the ovaries.

49. What is the pistil? Where is it situate? Of what is it composed? What is a *gymnophore*?

50. What parts compose a carpel? (Carpel: from the Greek, *karpos*, fruit.) What is the ovary? What is a style? What is the stigma?

51. Is the number of carpels always the same?



completely to each other. When the carpels remain entirely separate from each other, they constitute several distinct pistils, and when they are united into one mass, they form what is ordinarily called a single pistil. Sometimes this coherence takes place through the whole length of the carpels, sometimes in the ovaries, without the styles participating, so that the single mass formed by the ovaries, and ordinarily called a single ovary, is surmounted by two or more styles; and when the styles are united, the stigmas of the different carpels may be separate (*fig. 110*), or they may cohere (*fig. 104*).

52. The number of cells we find in an ovary when we cut through the lower part of a pistil, depends upon the number of carpels that are united together: sometimes there is but one, at other times two, three, four, five, or even more. Its general form is commonly ovoid (egg-shaped). Finally, the cell of each carpel encloses one or more ovules, which, by being developed, become seeds.



*Fig. 113.*—NARCISSUS.



*Fig. 111.*  
PISTIL.

58. The relations of the ovary with other parts of the flower vary, and furnish important characters for the classification of plants. Sometimes the base of this organ corresponds to the point at which both the stamens and perianth are inserted, so that the ovary is free at the bottom of the flower; it is then termed a *super-ovary* (*fig. 112*). At other times it is united entirely round the tube of the perianth, so as to form one body with the calyx, and is only free at its upper part; in this case the stamens and petals seem to arise above the ovary, and is said to be *infra* (below), or *adherent* (*fig. 113*). This latter arrangement carries with it the coherence of the sepals to each other: therefore, whenever the ovary is *infra*, the calyx is necessarily monosepalous.



*Fig. 112.*  
PISTIL.

*Explanation of Fig. 111.*—The pistil:—*a*, the torus;—*b*, the ovary;—*c*, the style;—*d*, the stigma.

52. Upon what does the number of cells in the ovary depend? What do the cells of the carpels contain?

53. What is a super-ovary? What is an infra-ovary?

## LESSON V.

*Development and Functions of Flowers—Flora's Calendar—Flora's Clock—Fertilization of Flowers—Fruit—Epicarp—Mesocarp—Endocarp—Carpels—Classification of fruits—Seeds ; their structure—Embryo—Cotyledons—Germination.*

## OF THE DEVELOPMENT AND FUNCTIONS OF FLOWERS.

1. Flowers are formed in certain plants long before they appear externally ; in the palms, for example, they remain concealed a year or even several years before they show themselves. They first appear in the form of a bud, which is generally a little larger than the buds of the leaves, and for a certain time their different constituent parts remain contracted ; they are then designated under the name of flower-bud (*fig. 114*) ; finally, when they approach a little nearer to the term of their growth, they expand or blow, and it is to this phenomenon that we ordinarily apply the name of *inflorescence* or *flowering* of plants.



*Fig. 114.*  
BUD.

2. Plants do not fade till they attain a certain age, which varies according to the species and according to circumstances, but this period is deferred in proportion to the slowness of the growth of the plant and the time it is destined to live. For instance, herbs fade on the first year of their existence ; some do not fade until the second year ; most shrubs only die in the second, third, or even fourth year ; and in trees, this phenomenon is more tardy. A certain degree of heat is necessary to effect inflorescence, and it is remarked that the same plant begins to fade sooner in warm countries than in cold ; it sometimes even happens, in the latter, that certain plants, if they can live at all, never fade. Too much moisture, and superabundant nourishment, by favouring the development of the leaves and stem, often contribute to retard inflorescence.

3. When a perennial plant has begun to blossom, it ordinarily produces new flowers every year at about the same period ; sometimes, however, this periodical return of inflorescence does not

*Explanation of Fig. 114.—A flower bud, magnified.*

1. How do flowers first appear ? What is a flower-bud ? What is inflorescence ?

2. When do plants fade ? What circumstances exert an influence over the duration of inflorescence ?

3. Is the recurrence of inflorescence regularly periodical in plants ?

occur with the same regularity, and when vegetation is injured by any circumstance, it may have barren years. It has also been observed, that when a tree has borne a great deal of fruit one year and retained it late, inflorescence is feeble or entirely wanting the succeeding year; and thus it is in the south of Europe, when the olives are left late upon the trees, the harvest fails the following year. Sometimes, on the contrary, the periods of inflorescence are more approximated, and in warm and humid autumns, we occasionally see plants flowering a second time.

4. The period of the year at which inflorescence takes place is generally definite for each species of plant, but varies a little according to the temperature and other atmospheric circumstances. For example, in the climate of Paris (which is similar to that of the Middle States), the black hellebore flowers in January; the hazel tree and willow in February; the box, the yew, the almond, the peach, the apricot, the primrose, the stock-gilly flower, in March; the plum, the pine, the ash, the elm, the yoke-elm, the hyacinth, the dandelion, &c., in April; the apple, the horse-chestnut, the lilac, the cherry, the peony, in May; the linden tree, the vine, oats, wheat, the wild red poppy, larkspur, in June; the violet, the carrot, hemp, lettuce, in July; asters, garden-balsams, and water-hyssop, in August; ivy, saffron, in September; Jerusalem artichoke and certain other plants, in October. The table of the different epochs of inflorescence constitutes what botanists have named *Flora's calendar*. In colder countries, inflorescence is retarded, while in the South it occurs earlier; for example, in Smyrna, the almond flowers in the first fortnight of February; in Germany, in the second half of April; and in Christiania (Sweden), in the first days of June.



Fig. 115.

5. The expansion or blooming of the flower is almost always effected by the separation of the pieces of the corolla and calyx from above downwards; but there are some in which the floral integuments remain adherent to the summit, and separate at the base, as in the vine, for example (*fig. 115*).

6. The period of the day at which this phenomenon occurs varies in the greatest number of plants, but in some it is fixed, and a series of plants arranged according to the hour at which the flowers blow, constitutes what Linnæus called *Flora's clock*. For example, at Paris, the bearbind (a species of bind-weed) blows between three and four o'clock in the morning; between

4. Does inflorescence recur in the same species of plant at the same period? What is meant by *Flora's calendar*?

5. How does a flower expand?

6. What is meant by *Flora's clock*?



four and five, certain of the *chicora'ceæ* expand; between five and six, the *convolvulus tricolor* appears; about seven, the lettuces, water-lilies, &c.; about eight o'clock, a species of chick-weed; about nine, the umbel-flowered marigold; at ten, the ice-plant; towards eleven, the purslain and the star of Bethlehem; about noon, most of the *ficoides* (fig-marigolds); about sunset, the evening primrose; between six and seven in the evening, the marvel of Peru; between seven and eight, the privet; and about ten in the evening, a bind-weed, which gardeners call a morning-glory, because they always find it open when they rise in the morning.

7. When the flower has arrived at a certain period of its development, the pollen formed by the anthers falls upon the stigma, and in this way causes the fecundation of the ovules, enclosed in the inferior part of the pistil; frequently the stamens are inclined towards the pistil that they may more conveniently deposit the pollen; for example, in the *geraniums*, the filaments of the stamens are curved so that the anther rests upon the stigma; and in the *nasturtium*, the eight stamens are each inclined in turn for eight successive days to deposit the pollen on the pistil in this way; and at other times this species of dust is cast into the air, and borne by the wind to the pistil of the same, or of a neighbouring flower.

8. It is easy to prove that the action of the pollen upon the pistil is indispensable to the fecundation of the ovules and the production of seeds which are developed in this organ. For example, it is sufficient to cut off the stamens of an hermaphrodite flower to render it sterile (provided it be sufficiently removed from other flowers, in which the stamens have not been destroyed), and when we have mutilated a flower in this way, it is sufficient to cast upon its stigma some pollen taken from another flower of the same species to make it produce seeds. In monœceous plants (that is, having flowers with stamens and flowers with a pistil only on the same stalk), as the maize, it is only necessary to remove the flowers with stamens to prevent the others from producing seeds; and when the plants are diœceous (that is, when the stamens and pistils are borne on different stems) the fecundating action of the pollen is still more evident; it has been long known that female date trees do not produce fruit, if they are very distant from trees of the same species bearing flowers with stamens; and in this case they will not bear, if we are not careful to dust over the branches, at the time of inflorescence, with

7. How are flowers fertilized by the pollen?

8. What evidence have we that the pollen is necessary for the fecundation of flowers?

pollen derived from the male date. This operation is daily practised on date trees in the East; and during the expedition of the French army in Egypt, the war having prevented the inhabitants of that country from procuring, as usual, flowers with stamens, they were deprived of their harvest of dates.

9. The grains of pollen that are deposited on the stigma meet there with moisture, swell, burst, and permit the escape of the granules contained within. These granules penetrate the spongy tissue of the pistil, and descend to the ovules which they are destined to fecundate. If the pollen is moistened before it reaches the stigma, it bursts in the same way; but in that case the granules it contains are lost, and fecundation does not take place; for this reason nature ordinarily gives to the corolla a form or position that protects the stamens against the action of moisture.

10. When the ovules are fecundated, the flower fades, and all the parts situate above the ovary, or that are not adherent to this organ (as is sometimes the case with the calyx), fall or dry up. But the ovules, as well as the parietes of the ovary, rapidly enlarge and constitute the fruit.

### OF FRUIT.

11. We give the name of *fruit* to the fecundated and increased ovary, and, by extension, we also understand by this term, the floral envelopes which may remain adherent to this organ.

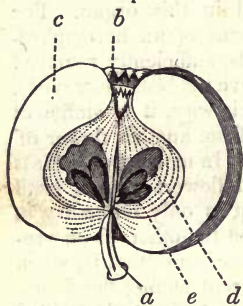


Fig. 116. — APPLE.

12. The fruit is essentially composed of two parts; namely, the ovules or seeds (*fig. 116, e*), and the carpels or ovaries which surround them, and for this reason they are called by some botanists the *pericarp* (*fig. 116, c, d*) (from the Greek, *peri*, around, and *karpos*, fruit). These two parts are never wanting, but the pericarp is sometimes so thin and so closely united to the seeds, that without a very careful examination, we would not believe that it existed at all.

*Explanation of Fig. 116.*—Fleshy fruit (an apple);—*a*, the peduncle;—*b*, the remains of the limb of the calyx;—*c*, the sarcocarp, surrounded by the calyx;—*d*, the lodges or cells lined by the endocarp;—*e*, the seeds.

9. What takes place after the pollen has been deposited on the stigma?
10. What becomes of the flowers after the fertilization of the ovules?
11. What is meant by fruit?
12. Of what parts is the fruit composed?

13. A carpel may be compared, as we have before said, to a leaf folded upon itself (that is, the edges rolled inwards towards its midrib), and, like it, is composed of three layers; namely, an external membrane, which represents the epidermis of the inferior surface of the leaf, and in the fruit is named *epicarp* (from the Greek, *epi*, upon, and *karpos*, fruit); a middle layer, which is analogous to the parenchyma of the leaf, and is called the *mesocarp* (from the Greek, *mesos*, the middle, and *karpos*, fruit), or *sarcocarp* (from the Greek, *sarx*, flesh, and *karpos*, fruit, flesh of the fruit); finally, an internal membrane or *endocarp* (from the Greek, *endon*, within, and *karpos*, fruit), which corresponds to the superior surface of the leaf; also, the *pericarp*, which is nothing but the united or agglutinated carpels, is essentially composed of three layers; namely, the epicarp, which occupies the surface of it, the *mesocarp*, which is more deeply situated, and the endocarp, which lines the lodges or cells in which the seeds are found.



Fig. 117.  
PERICARP.

14. The epicarp frequently has upon its surface, hairs, glands, and stomata; in general, it is thin and flexible, and is often easily detached from the subjacent parts; it is this membrane which forms the velvety skin of the peach and of the plum. When the ovary is *infra*, that is, whenever it is united with the tube of the calyx, it is this tube which constitutes the epicarp, and then we always distinguish at its superior part, the teeth or divisions of the limb, or at least a border formed by the remains of this part of the floral envelope, which fades after fecundation (fig. 116, *b*).

15. The mesocarp is the parenchy'matous portion in which all the vessels of the fruit are united. It frequently presents a very considerable thickness and a fleshy consistence (which has obtained for it the name of *sarcocarp*), as in the peach, the apricot, the cherry, &c., and constitutes the part we eat. Sometimes the mesocarp is dry and fibrous, as in the almond, or it constitutes the part called the *shell*; and at other times it is so thin as to be hardly distinguished.

16. The *endocarp* which internally lines carpels or ovaries, and constitutes the layer of the pericarp nearest the seed, varies much. In most fruits it is thin and transparent (as in the husk

*Explanation of Fig. 117.*—Fruit of a palm tree opened;—*a*, the pericarp, composed of three layers, called *epicarp*, *mesocarp*, and *endocarp*;—*b*, the seed;—*c*, its embryo.

13. Of what parts is a carpel composed?

14. What is the epicarp?

15. What is the mesocarp?

16. What is the endocarp?



of beans, for example), but at other times it becomes hard and brittle, and forms what is named the *stone* of the fruit.

17. Each carpel has two edges, one named *dorsal*, which corresponds to the primary nerve of this appendage, and another, called *ventral*, which results from the agglutination of these two edges to each other; and, when the edges of the carpel, in place of being simply joined, are folded inwards, they constitute an internal partition which divides the ovarian cell or cavity into two parts.

18. The carpels are sometimes single in each flower, sometimes more or less numerous, and in this last case they may be agglutinated to each other in different ways, and constitute compound fruits, the appearance of which varies. Sometimes they are very distinct externally, at other times are united with the torus and with the calyx in such a manner that no trace of external union can be seen, and constitute a simple fruit (*fig. 116*). In general the cells of different carpels united into a single mass, are perfectly distinct, and the compound fruit consequently presents as many cells as there are carpels; but sometimes the carpels are not closed along their ventral edge, and then the cells of all these organs communicate with each other, and constitute a single cavity, of which the circumference only is more or less lobed. And it also happens sometimes that the partitions, which separate the neighbouring cells, are in part destroyed by the progress of maturation, and all the cells of a compound fruit are united into a single cavity, the centre of which is occupied by a species of column formed by the remains of the ventral edge of the carpels thus united. Often one or more carpels abort and leave no trace of their existence. Finally, not only may the carpels of the same flower be united to each other, but sometimes those of neighbouring flowers approximate, and become agglutinated into a single mass, and thus constitute what is termed an *aggregate fruit*. Figs, and the cones of the pine tree are composed in this way.

19. At the period of their maturity fruits present still other important differences; some are *indehiscent* (from the Latin *in*, not, and *dehiscere*, to gape wide open), that is, they do not open spontaneously; others, on the contrary, open of themselves, and are called for this reason, *dehiscent*. In simple fruits, the opening generally takes place at the agglutinated edges of the carpel, or by this and the dorsal edge at the same time, so that the fruit is divided into two pieces called *valves*. In the compound fruits,

17. What is meant by the dorsal and ventral edges of a carpel?

18. Have all flowers the same number of carpels? What is meant by an aggregate fruit?

19. What is meant by an indehiscent fruit? What is a dehiscent fruit?

we sometimes see the different carpels separate and fall singly then remain closed, or open in the same way as the simple fruits; sometimes also the back of each cell is torn without the carpels being separated.

The differences that we have pointed out in the conformation of fruits and the principal variations of form which they present, have led botanists to class them as follows:

### CLASSIFICATION OF FRUITS.

20. All fruits are included in three classes.

21. The first CLASS is composed of the SIMPLE or APOCARPOUS fruits, formed of a single carpel or of several free carpels.

The first division of this class includes what are termed *dry fruits*, having a thin pericarp and being but slightly furnished with juices, and generally contain only a small number of seeds.

22. This division contains two varieties; the first are the *indehiscent*, simple fruits: under this head we have the three following forms:

*Caryopsis*.—Fruit monospermatic (from the Greek, *monos*, single, and *sperma*, seed, having one seed) and indehiscent, the pericarp of which is very thin, and intimately connected with the seed, as wheat, barley, rice, oats, &c.

*Akene* or *achenium* (from the Greek, *a*, without, and *chainò*, I gape).—Fruit monospermatic and indehiscent, the pericarp of which is distinct from the proper covering of the seed, as in hemp, sunflower, &c.

*Gland* or *nut*.—Fruit unilocular (from the Latin, *unus*, one, and *loculus*, partition, seed-vessel not separated into cells) and therefore monospermatic, from the constant abortion of all the ovules except one; \* the coriaceous or woody pericarp of this one presents at its summit vestiges of the limb of the calyx, and is enclosed, either partly or entirely, in a kind of involucre called *cupule*, as in the oak.

23. The second variety of the first division of the first class contains the three following *dehiscent* fruits:

\* If we regarded the carpels which constantly abort in glands, acheniums, &c., we must place these in the class of compound fruits; but most botanists place them here, because, at maturity, they are essentially composed of a single carpel.

20. How are fruits classified?

21. What are the general characters of fruits of the first class?

22. What is a caryopsis? What is an achenium? What is a gland or nut?

23. What is a follicula? What is a legume? What is a lomentum?



Fig. 118.

*Follicula* (little bag — follicle). — Fruit ordinarily membranous, opening longitudinally on the ventral surface, as the larkspur, senna, &c.

*Legume* or *husk*. — Fruit which is ordinarily membranous, elongated, and compressed in form, opens longitudinally both by the ventral and dorsal suture at the same time, as peas, beans, &c. (fig. 118).

*Lomentum*. — Fruit similar to a pod or legume, but contracted at different points, forming partitions which result from the cohesion of the two faces of the carpel, and opening by transverse sections, as in *Cassia fistula* (fig. 119).

24. The second division of the first class contains *fleshy fruits*, having a thick, pulpy, and succulent pericarp; they are never dehiscent.

It contains the two following forms:

*Drupe*. — Fruit fleshy, enclosing a nut internally (the mesocarp being fleshy and very thick, and the endocarp coriaceous, or bony), as the peach, the apricot, the cherry, &c.

*Nut*. — Fruit similar to a drupe, but the mesocarp is less thick, and constitutes what is called a *shell* (as the fruit of the almond). Sometimes these fruits, in place of being isolated, are grouped together on a fleshy *gynophore* so as to resemble a compound fruit, as in the strawberry and raspberry.

25. The SECOND CLASS is composed of fruits that are COMPOUND OR SYNCARPOUS (from the Greek, *sun*, with, and *karpos*, carpel or fruit): they are formed of several carpels of the same flower agglutinated together.

26. The fruits of the first division of the second class are free, not being united to the calyx or perigon through the medium of the torus. The first variety contains the two following *dehiscent* fruits:

*Silique* or *siliqua*. — Fruit dry, analogous to a legume, but bilocular (from the Latin, *bis*, two, and *loculus*, partition), and having the seeds attached upon the two edges of the partition in each cell, as the cabbage, rose, &c.

*Capsule*. — Fruit dry, formed of two or more carpels united together, and opening in different ways, but not bivalve, as the poppy.

Fig. 119.  
CASSIA.

24. What is a drupe? What is a nut?

25. What are compound fruits?

26. What is a silique? What is a capsule?



27. The second variety of the first division of the second class consists of the following *indehiscent* fruit :

*Hesperide* — orange. — Fruit fleshy, composed of a common epicarp, and several cells formed by the endocarp of different carpels, and filled with a sort of pulp, as the orange, citron, &c.

The fruits of the second division of the second class are adherent, being united to the calyx or perigon through the medium of the torus.

28. The first variety of this division contains *fleshy* or *pulpy* fruits.

*Pome* or *apple*. — Fruit composed of several indehiscent carpels with a cartilaginous or bony pericarp, completely enveloped by a fleshy indehiscent calyx to which they are agglutinated, as the apple, pear, medlar, &c.

*Melonide* or *pepo*. — Fruit unilocular, formed of several indehiscent carpels with edges not infolded, and enclosing numerous seeds surrounded by a pulp, as melons, gourds, &c.

*Berry*. — Fruit multilocular, indehiscent, semi-fluid internally, as gooseberries, &c.

The second variety includes dry fruits and certain adherent capsules, &c.

29. The **THIRD CLASS** is composed of fruits that are **AGGREGATED** or **POLYANTHOCARPOUS** (from the Greek, *polus*, many, *anthos*, flower, and *karpós*, fruit, fruit from many flowers), because these fruits are formed by the approximation or agglutination of the fruits of many flowers. The three following are placed in this class :

*Cone*.—An assemblage of sessile fruits concealed at the base of convex scales formed by bracts, or by a ligneous pericarp, as the pine, savin, &c.

*Sycone*.—An assemblage of very small fruits analogous to drupes, enclosed in a fleshy concave receptacle, as figs (*fig.* 78).

*Sorose*.—An assemblage of fruits attached to a single body, by means of their floral envelopes, which are fleshy and united so as to resemble a mammalated berry, as the mulberry, &c.

“Of the terms above explained only a few are in common use, and it seems to be found by systematic botanists more convenient to describe a given fruit by exact words, than to use any particular term. The names most employed are achenium, nut, caryopsis, drupe, capsule, siliqua, legume, and cone.”—*Lindley*.

27. What is a hesperide ?

28. What is a pome ? What is a pepo ? What is a berry ?

29. What are aggregated fruits ? What is a cone ? What is a sycone ? What is a sorose ?

## OF SEEDS.



Fig. 120.  
SEEDS.

30. The seeds, which, during the early period of their development, are called *ovules*, are produced in the interior of the cells of the carpel or ovary, along the ventral suture of this organ (fig. 120).

31. That part of the carpel from which the seeds spring is named the *placenta* or *trophosperm* (from the Greek, *trephe*, I nourish, and *sperma*, seed, seed-nourisher), and the stalk or thread by which the seeds are attached to it, we call the *funicula* (Latin, little cord) or *podosperm* (from the Greek, *pous*, in the genitive, *podos*, foot, and *sperma*, seed, seed-foot or seed-stalk).

32. The funicula in general resembles a little pedicle, and its extremity is expanded sometimes around the seed so as to envelope it more or less, and constitute what is named the *aril* (arillus). Sometimes this expansion of the funicula is thick and fleshy; sometimes thin and membranous; its form varies considerably. In the nutmeg tree, for example, the aril forms a fleshy lamina of a bright red, divided in shreds which envelope the nutmeg, and constitutes the spice called mace. It is to be remembered that the aril is found only in those plants that have a monopetalous corolla.

33. The seed itself is the part of the perfect fruit contained in the interior of the carpel, and encloses the body which is destined to become the new plant. The point by which it adheres to its funicula, generally has the appearance of a small scar or cicatrix, and is called the *hilum*. Finally, the seed is composed of two series of organs; namely, the accessory parts, and the essential parts.



Fig. 121.

34. The accessory parts of the seed are divided into the *spermoderm* (from the Greek, *sperma*, seed, and *derma*, skin) or *episperm* (from the Greek, *epi*, upon, and *sperma*, seed), and the *albumen*; the essential part is called the *embryo* (fig. 121).

35. The *spermoderm* or skin of the seed is sometimes a simple membrane, and sometimes a

*Explanation of Fig. 121.*—The seed of a bean, split open to show the spermoderm (a), the plumule (c), and the radicle (b).

30. Where are seeds formed? What are ovules?

31. What is the placenta? What is the funicula?

32. What is the aril? What is mace?

33. What is the hilum?

34. What constitutes the accessory parts of the seed?

35. What is the spermoderm?

covering composed of two or even three coats. The nutritious vessels of the seed, which come from the trophosperm, ramify in the thickness of this seed-covering, and we usually perceive near the centre of the hilum a minute hole, which gives them a free passage.

36. The *albumen*, also called *perisperm* (from the Greek, *peri*, around, and *sperma*, seed) or *en'dosperm* (from the Greek, *endon*, within, and *sperma*, seed); the *albumen* is a body intermediate between the *spermoderm* and the *embryo*, which surrounds the latter (embryo) and ordinarily constitutes a depot of nutritive matter. In general it is formed of a kind of cellular tissue, in which is found the secula, as in wheat; at other times it encloses fatty matter, as in the castor oil plant (*palma christi*); frequently it is very thin, and sometimes it is entirely wanting.

37. The *embryo* or essential part of the seed is the rudiment of the new plant which the seed is destined to produce. In plants unprovided with albumen or perisperm, the embryo consists of a single *kernel* or *almond*, and fills the spermoderm. In this case we call it an *epispermatic embryo*, because it is covered immediately by the *episperm*, or internal layer of the spermoderm. But in plants that are provided with an albumen, the kernel is composed of the latter united to the embryo. (In this instance it is termed an *endospermatic embryo*.) In this latter case the position of the embryo may vary considerably; sometimes it is simply applied upon a point of the surface of the albumen, which presents for its reception a little pit (fossette), as in the grain of wheat, or it may be rolled around the albumen so as to envelope it, more or less completely; it is then said to be *extra*: at other times it is entirely enclosed in the interior of the albumen, and then takes the name of *intra embryo*, as in the castor-oil seed.

38. We distinguish in the embryo, that is, in the young plant which is still enclosed in the seed, three principal parts; the *radicle*, the *plumule*, and the *coty'ledons* (figs. 121 and 122).

39. The *radicle* (figs. 124 and 125) is the young root, which before germination is always simple, but by development it is more or less divided, and constantly tends towards the centre of the earth.

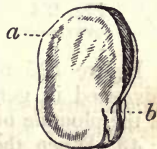


Fig. 122.—BEAN.

*Explanation of Fig. 122.*—The seed of a bean:—*a*, the coty'ledons;—*b*, the radicle.

36. What is the albumen?

37. What is the embryo?

38. What parts are distinguished in the embryo?

39. What is the radicle?



40. The *plumule* (figs. 121, *c*, and 125, *d*) or young stem is sometimes scarcely visible before germination; at other times it is as long as the radicle with which it is inferiorly continuous: by development it becomes elongated in a direction contrary to that of the root, and consequently it always tends to rise. We distinguish in it two parts, namely: the *stemmule* and the *gemmule*, situate one above and the other below the coty'ledons.



Fig. 123.  
COTYLEDON.

41. The *coty'ledons* are lateral appendages which represent the first leaves (fig. 123). They are almost always thick and fleshy in plants unprovided with albumen, but thin and membranous in endospermatic seeds. Their use seems to be to furnish the young plant with the first alimentary matter, and their number is various; sometimes there is but one and at others there are two or more.

42. Plants whose seeds contain only a single coty'ledon, are named *monocoty'ledons* (from the Greek, *monos*, single, and *kotuledon*, seed-lobe); those whose seeds contain two or more coty'ledons, are named *dicoty'ledons* (from the Greek, *dis*, two, and *kotuledon*, seed-lobe).

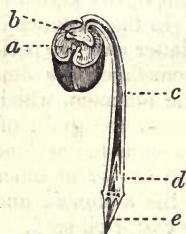


Fig. 124.  
COTYLEDON.

The annexed figure (124) represents the section of a seed of a monocoty'ledon in process of germination, showing the perisperm (*a*); the summit of the single coty'ledon (*b*); the base of the coty'ledon, forming a sort of tube (*c*); at the lower part of the base we see the plumule (*d*), which sets upon the radicle (*e*).

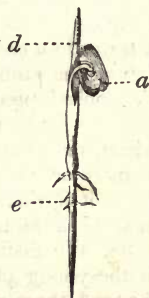


Fig. 125.  
COTYLEDON.

Figure 125 represents the same seed, further advanced in germination, after the appearance of the plumule or young stem (*d*).

43. When the seeds are ripe or a short time afterwards, they separate from the plant; sometimes the fruit opens spontaneously to permit their escape; at other times they are detached without

*Explanation of Fig. 123.*—A seed in process of germination:—*c*, base of the coty'ledon.

40. What is the plumule? (Plumule: from the Latin *plumula*, a little feather.)

41. What are coty'ledons? What is their use?

42. What is meant by a monocoty'ledon? What is dicoty'ledon?

43. How are seeds naturally distributed?

its opening, and the pericarp is sown entire, or in part, with the seed. Most seeds fall upon the surface of the ground, and nature resorts to various means to secure their dispersion: sometimes they are surmounted by a little plume which takes the wind; at other times they are furnished with wings, so as to be readily carried to a distance; they are often conveyed to great distances by the currents of rivers or of the sea; and occasionally their dissemination is effected in a still more singular manner, for it frequently happens that birds eat fruits, the seeds of which they do not digest, but afterwards discharge at some more or less distant place, where they germinate and grow.

44. The number of seeds produced by most plants is so considerable that if every seed germinated, the product of some square leagues of land would be equivalent, according to several calculations, to the vegetation of the whole world. For example, 160,000 seeds have been counted on a single stalk of tobacco, and 629,000 on an elm. But this seeming prodigality on nature's part is only a wise precaution against the numerous causes of destruction to which they are exposed.

#### OF GERMINATION.

45. The term germination is applied to the series of phenomena that a seed presents, in effecting the development of the embryo it contains. *Germination* cannot take place except under a concurrence of circumstances dependent on the seed itself and external influences. The seed must be ripe, enclose a complete embryo, and not be too old. There are some seeds that retain the faculty of germinating for a very long time; wheat and beans enjoy this property for sixty and even a hundred years, while coffee, on the contrary, loses it in a very short time. Some, when protected from contact with the air, preserve their germinative faculty for a long period: on the other hand, the seed must be subject to the action of certain external agents, the chief of which are *water, heat, and air*. Water is indispensable to germination; it acts by penetrating the substance of the seed, by softening its envelopes, by causing the embryo to swell, and by bringing about in the endosperm or in the cotyledons, chemical changes, which render the substances deposited in their paren'chyma (from the Greek, *paregchuein*, to strain through,—the spongy and cellular tissue of organized bodies) fit to nourish the young plant. Heat is also necessary: below a certain temperature the seed remains

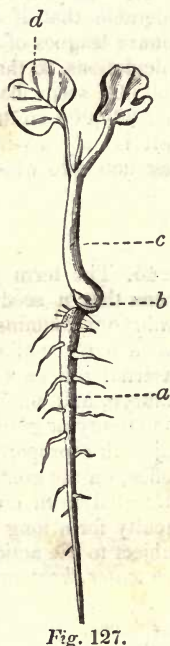
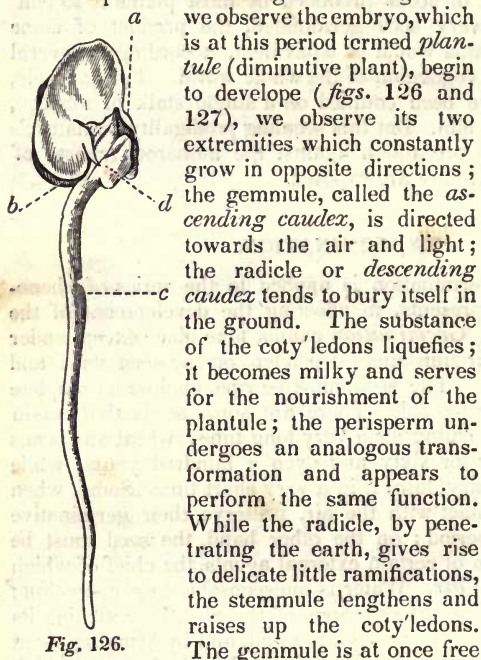
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44. Are the seeds of plants very numerous?

45. What is meant by germination? What circumstances are essential to germination?

inactive; too much heat destroys the vegetative power; the extreme limits are between thirty-two and one hundred and twenty-two degrees of Fahrenheit's thermometer. The presence of air is as indispensable to the germination of seeds, or at least to their development, as it is to the respiration of animals. It acts through the means of the oxygen it contains; seeds placed in contact with this gas are stimulated in their germination. Light, on the contrary, hinders or at least retards it much.

46. The first phenomenon observed in germination is the swelling of the seed and the softening of its envelopes; the time at which the latter burst varies in different plants; the manner of this rupture is either regular or irregular. From this moment



*Explanation of Fig. 126.*—Seed of a bean in a state of germination;—*a*, the spermoderm split;—*b*, cotyledons;—*c*, radicle;—*d*, plumule.

*Fig. 127.*—The same bean in a more advanced stage of development;—*a*, radicle;—*b*, collum or neck;—*c*, the stemmule;—*d*, the cotyledonous leaves.

46. What is the first phenomenon observed in germination? What is the ascending caudex? What is the descending caudex? When does germination cease?



and uncovered ; the little leaves of which it is composed expand, increase in size, become green, and begin to draw from the atmosphere a portion of the fluids which nourish the young plant. The act of germination is now at an end, and nutrition goes on as we described it when speaking particularly of this function.

47. All seeds do not require the same period of time for their germination. For instance, certain cresses germinate in two days ; the turnip and bean in three days ; lettuce in four ; the melon in five ; most of the grasses in six or seven days ; the hyssop in a month ; the peach in a year, and rose tree in two years, &c.

48. What we have hitherto said of fructification relates entirely to cotyledonous plants ; and we have still to say a few words of what takes place in *acotyledons* (from the Greek, *a*, without, and *kotyledon*, seed-lobe), in which we find neither flowers, nor seed, nor embryo. The class of *acotyledons* comprises all plants which are unprovided with true organs of generation, that is, stamens and pistils ; on this account they are named *cryptogamous* (from the Greek, *kruptos*, concealed, and *gamos*, marriage) or *agamous* (from the Greek, *a*, without, and *gamos*, marriage), and are produced through the means of corpuscles, analogous in their structure and development to the *bulbills* or *bulblets* of certain perennial plants. These corpuscles (minute bodies) are named *sporules* or *seminules* ; they are contained in envelopes called *conceptacles*, and are variously placed either in the interior of the plant itself, or (but more rarely) on its exterior in the form of tubercles, as we shall see when we come to speak of the history of these plants.

47. Do all seeds require the same time for germination ?

48. What are *acotyledons* ? What plants are contained in the class of *acotyledons* ? What are *cryptogamous* plants ?

## LESSON VI.

CLASSIFICATION OF PLANTS.—*Natural and artificial Methods*—*Artificial System of Linnæus*—*The Natural Method of Jussieu.*

CRYPTO'GAMOUS PLANTS.—*Lichens, Fungi, Agarics, Truffle, Algæ, Mosses, Ferns.*

PHANERO'GAMOUS PLANTS—*Monocoty'ledons*—*Grasses*—*Wheat, Rye, Barley, Malt, Oats, Rice, Maize, Sugar-cane, Sugar, Sugar-candy*—*Palms*—*Narcissus*—*Dicoty'ledons*—*Apetalous Dicoty'ledons*—*Monopetalous Dicoty'ledons*—*Potatoe, Tobacco, Belladonna, Olive, Sage, Coffee*—*Polypetalous Dicoty'ledons*—*Hemlock, Mallow, Cotton, Flax, Orange, Tea, Vine, Wine, Poppy, Sensitive Plant, Apple, Pear, Plum, Cherry, Apricot, Peach, Strawberry, &c.*—*Diclineæ*—*Hop, Hemp, Elm, Bread-fruit, Oak, Chestnut, Ash, Pine*—*Of the Uses of Plants*—*Examples of ornamental Plants.*

## CLASSIFICATION OF PLANTS.

1. As we stated when beginning the natural history of animals, we give the name of classification to any arrangement designed to facilitate the determining and study of objects, by separating them into more or less numerous groups, which, in their turn, are again divided and subdivided; and by assigning to each of these divisions a name and character suitable to enable us to recognise all bodies of which they are composed.

2. With this view we make use of two kinds of classification; one called an *artificial system*, and the other a *natural method*.

3. AN ARTIFICIAL SYSTEM or *classification* of plants is a mode of arrangement by means of which we may readily obtain a knowledge of the name of a plant, by examining the characters furnished in the conformation of certain parts of these beings. In this kind of classification we divide and subdivide the vegetable kingdom into groups, into each one of which we range all those plants which possess a certain character, selected arbitrarily, and exclude all those that do not possess this same character, without considering whether we separate in this way, plants that resemble each other in all the most important relations, or whether we bring together in the same division, other plants that

1. What is meant by classification?

2. By what modes are plants classified?

3. What is understood by the artificial method or system of classification?

possess scarcely any property in common with each other. On this principle we might class plants according to the variations observed in the form and structure of the leaves, or of the corolla of the flower, or any other organ ; but by proceeding in this way, we should learn almost nothing in relation to the organization of these beings, or in respect to the degrees of resemblance or dissimilarity they possess.

4. A *natural method* or *classification* is, on the contrary, a sort of synoptical table of all the modifications that nature has produced in the conformation of plants, a table in which these modifications are arranged according to their relative importance, and serve for the establishment of divisions and successive subdivisions. In consequence of this, plants arranged according to this method have more important and more numerous points of resemblance to each other in proportion to their approximation to each other in the classification ; for instance, when two plants are placed in two different divisions, it is because they differ from each other in more respects than either of them differs from all the other plants with which it is arranged, and these differences are less important between different species of the same genus than between the different genera of the same family. Those characters which distinguish the families from each other are, in their turn, of less importance than those employed to separate from each other the groups formed by the union of several of these families, and so on. By the assistance of these methods we determine the name of a plant we wish to know with less facility than by an artificial system, but we acquire much more important knowledge, because, having thus ascertained the place a plant occupies in a classification of this kind, we know the principal features of its mode of organization, and consequently its physiological history also.

5. Botanists have successively employed different artificial systems and the natural method in the classification of plants. Among the first, there is one which, from its simplicity, and the celebrity it for a long time enjoyed, merits being cited here ; it is the *System of Linnæus* (a Swedish botanist who died in 1778), which is based upon the differences that plants present in the various essential parts of their flowers, but especially in their stamens.

6. In this system of classification plants unprovided with stamens and pistils form a particular class, and those which possess these organs are divided : *first*, according to the existence of stamens and pistils in the same flower, or in different flowers ;

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4. What is meant by the natural method ?

5. Which method or system of classification is employed by botanists ?

6. Upon what principle is the artificial system of Linnæus based ?



*second*, according to the cohesion of the stamens to each other or with the pistil, or according to their not cohering; *third*, according to the relative length of the stamens; *fourth*, according to the number of stamens, &c.

7. The first eleven classes are characterized by the number of stamens. The names of these and the two succeeding classes are formed from the Greek by prefixing the proper numerals to the word *aner* (man), used metaphorically for stamen.

Class 1. MONANDRIA: includes all plants with perfect flowers that have but one stamen.

- 2. DIANDRIA: two stamens.
- 3. TRIANDRIA: three stamens.
- 4. TETRANDRIA: four stamens.
- 5. PENTANDRIA: five stamens.
- 6. HEXANDRIA: six stamens.
- 7. HEPTANDRIA: seven stamens.
- 8. OCTANDRIA: eight stamens.
- 9. ENNEANDRIA: nine stamens.
- 10. DECANDRIA: ten stamens.
- 11. DODECANDRIA: eleven to nineteen stamens.

8. The two succeeding classes are characterized by the number of the stamens with their mode of insertion.

- 12. ICOSANDRIA: twenty or more stamens which are attached to or stand upon the calyx; as in the apple, cherry, &c.
- 13. POLYANDRIA: twenty or more stamens which do not adhere to the calyx, that is, the stamens are *hypogynous*.

9. The two following classes are characterized by the *relative* length of their stamens:

- 14. DIDYNA'MIA (from the Greek, *dis*, two, and *dunamis*, power): two long and two shorter stamens, as in mint.
- 15. TETRADYNA'MIA (from the Greek, *tetteres*, four, and *dunamis*, power): four long, and two short stamens,—the longer stamens are supposed to be the most powerful.

10. The four following classes are characterized by the connexion of the stamens.

- 16. MONODE'LPHIA (from the Greek, *monos*, single, and *delphos*, brotherhood): having the filaments of all the stamens united into a set or tube, constituting a single brotherhood, Example, the mallow.
- 17. DIADE'LPHIA (from the Greek, *dis*, two, and *delphos*): having the filaments of the stamens united in two sets, as in the pea.

7. How are the first eleven classes of the Linnæan system named and characterized?

8. How is the class Icosa'ndria characterized? How is the class Polyandria characterized?

9. How is the class Didyna'mia recognised? What are the characters of the class Tetradyna'mia?

10. What are the characters of the class Monodelphia? What are the characters of Dia'delphia? What are the characters of Polya'delphia?

18. POLYDE'LPHIA (from the Greek, *polus*, many, and *delphos*): having the filaments of the stamens united into more than two sets.
19. SYNGENE'SIA (from the Greek, 'sun, together, and *geinomai*, to arise, to grow): having the stamens united by their anthers in a ring or tube, as in the sunflower.
20. GYNA'NDRIA (from the Greek, *gune*, woman, used metaphorically for pistil, and *aner*, stamen): having the stamens, in appearance, growing out of the pistil, as in the ladies' slipper.

In all the preceding classes the flowers are perfect.

11. The next three classes are characterized by the stamens and pistils being separately contained in different flowers.

21. MONOE'CIA (from the Greek, *monos*, single, and *oikia*, house): the stamens and pistils are in separate flowers, but both grow on the same plant, or both dwell in the same house, as the name denotes.
22. DIOE'CIA (from the Greek, *dis*, two, and *oikia*): the stamens and pistils are not only in separate flowers, but on different individuals,—they are in two households.
23. POLYGA'MIA (from the Greek, *polus*, many, and *gamos*, marriage or union): the stamens and pistils are separate in some flowers, and united in others, all on the same, or on two or three individuals of the same species.

12. The last class includes flowers in which neither stamens nor pistils are visible. They are now termed flowerless plants.

24. CRYPTOGA'MIA (from the Greek, *kruptos*, concealed, and *gamos*, marriage): having the essential organs of the flower concealed from view.

A synoptical view of the Linnæan classes is seen in the following:

What are the characters of Syngenesia? What are the characters of Gynandria?

11. What are the characters of Monœcia? What are the characters of Dioœcia? What are the characters of Polygamia?

12. What are the characters of the class Cryptogamia?





13. In the first thirteen classes of the Linnæan system, the orders are founded on the number of styles, and when these are wanting, on the number of stigmas. The names of these orders are formed by prefixing numerals from the Greek to the word *gynia*,—from *gune* (woman), metaphorically used for pistil.

|          |               |                               |
|----------|---------------|-------------------------------|
| Order 1. | MONOGYNIA :   | 1 style, or sessile stigma.   |
| 2.       | DIGYNIA :     | 2 styles, or sessile stigmas. |
| 3.       | TRIGYNIA :    | 3 “ “                         |
| 4.       | TETRAGYNIA :  | 4 “ “                         |
| 5.       | PENTAGYNIA :  | 5 “ “                         |
| 6.       | HEXAGYNIA :   | 6 “ “                         |
| 7.       | HEPTAGYNIA :  | 7 “ “                         |
| 8.       | OCTAGYNIA :   | 8 “ “                         |
| 9.       | ENNEAGYNIA :  | 9 “ “                         |
| 10.      | DECAGYNIA :   | 10 “ “                        |
| 11.      | DODECAGYNIA : | 12, or about twelve.          |
| 12.      | POLYGYNIA :   | more than 12.                 |

The sixth, seventh, eighth, and ninth orders are very rarely found.

14. The 14th class, *Didyna'mia*, contains two orders, named and characterized as follows :

GYMNOSPE'RMIA (from the Greek, *gumnos*, naked, and *sperma*, seed) : has naked seed, commonly four in number.

ANGIOSPE'RMIA (from the Greek, *aggeion*, a vessel, and *sperma*, seed) : has the seeds, which are usually numerous, enclosed in a seed-vessel.

15. The 15th class, *Tetradyna'mia*, has two orders, distinguished by the form of the fruit.

SILICULO'SA : fruit a silicle or roundish pod.

SILIQUO'SA : fruit a silique.

16. The orders of the 16th, 17th, and 18th classes are founded on the characters of the first thirteen classes. For example, the mallow, which belongs to the 16th class, *Monodelphia*, has more than 20 stamens, and therefore belongs to the order *Polyandria* of that class.

17. The 19th class, *Syngenesia*, has five orders, characterized by the nature of the florets, whether perfect, separated, or barren.

1. POLYGAMIA ÆQUALIS has perfect florets, that is, furnished with both stamens and pistils. Example, the thistle.

2. POLYGAMIA SUPERFLUA has the florets of the disk perfect, and those of the ray furnished with pistils only. Example, the aster.

13. On what characters are the orders of the first 13 classes of the Linnæan system founded ?

14. What are the orders of the class *Didynamia* ?

15. What are the orders of *Tetradynamia* ?

16. On what characters are the 16th, 17th, and 18th classes founded ?

17. What are the orders of *Syngenesia* ?

3. **POLYGAMIA FRUSTRANEA**: has the florets of the disk perfect; those of the ray without either stamens or pistils which are well formed. Example, the sunflower.
4. **POLYGAMIA NECESSARIA**: has the florets of the disk with stamens only, the stigmas being imperfect; and those of the ray with pistils only. Example, silphium.
5. **POLYGAMIA SEGREGATA**: has all the florets perfect, and each floret has a well formed calyx, the whole being enclosed in an involucre. Example, elephantopus.

The orders of the 20th, 21st, and 22d classes are for the most part characterized by the number of stamens.

18. The 23d class, *Polygamia*, has three orders founded on the immediately preceding orders.

1. **MONÆCIA** has both separated and perfect flowers on the same individual.
2. **DICÆCIA**: when one individual bears the perfect, and another the two kinds of separated flowers.
3. **TRICÆCIA**: when one bears the perfect, a second the staminate, and a third the pistillate flowers.

The Ferns, Mosses, Algæ, Fungi, &c., constitute the orders of the 24th class, *Cryptogamia*.

19. The basis of the *natural method* was proposed by a French botanist, Bernard de Jussieu, and this classification, perfected by the labours of Antoine Jussieu (pronounced *jus-sue*), and the botanists of his school, is the one now generally adopted. According to this classification, we bring together, in groups called *genera*, all the species of plants which resemble each other throughout, in the important characters of their organization; and in the same manner we bring together, into divisions of higher rank, named *natural families*, the different genera, the most essential organs of which possess an analogous mode of structure: then we group together the natural families according to the same principle, and finally obtain a small number of divisions which comprise all the subdivisions we have mentioned above, and which, by their union, include the whole vegetable kingdom.

20. The most important differences among plants, consist in the absence or presence of flowers or organs of fructification, and this difference almost always coincides with their peculiar modes of organization in all their parts, such as the absence or presence of distinct vessels in the tissue of the plant. Therefore, in a natural method, we must first divide the vegetable kingdom into two groups; one containing plants which are reproduced by means of flowers, and the other including plants

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18. What are the orders of the class *Polygamia*?

19. What is the basis of the natural method of arranging plants?

20. What are the most important differences among plants? Into how many groups is the vegetable kingdom divided? What are they?

which are not multiplied in this way, and unprovided with flowers. This is, in fact, the course followed ; we ordinarily designate the first of these divisions under the name of *cotyle'donous* or *phanero'gamous* plants, and the second under the name of *acotyle'donous* or *crypto'gamous* plants.

21. The *phanero'gamous* (from the Greek, *phaneros*, evident, and *gamos*, marriage) or *cotyle'donous* plants all resemble each other in the most important particulars of their organization, but nevertheless very greatly differ from each other ; in some, the seed contains but a single coty'ledon, and the stem is en'dogenous ; the others have seeds provided with two or more cotyledons, and an ex'ogenous stem ; consequently we divide them into two groups, which are called *monocoty'ledons* and *dicoty'ledons*.

22. Among the *crypto'gamous* plants, there are some which are composed exclusively of cellular tissue, and do not possess any distinct organs that are analogous either to roots, stems, or leaves ; there are others which, although composed chiefly of cellular tissue like the first, often acquire vessels at a certain period of their development, and are provided with parts analogous to the roots and leaves of ordinary plants. In order that the classification of these plants be natural, that is, the expression of the more or less important resemblances or differences they present, we must, therefore, form them into two divisions ; that of cellular plants properly so called, and that of *semi-vascular* plants.

23. We subdivide the *monocoty'ledonous* and *dicoty'ledonous* plants into classes according to the structure of their flowers, and, to characterize the groups thus formed, we ordinarily take into consideration, first, the absence or existence of a corolla, &c., then we make a distinction between the monopetalous and polypetalous corolla ; then we consider the manner of insertion of the stamens or petals when they possess stamens. Finally, the classes thus formed are subdivided into natural families according as nature has variously modified the general mode of organization of the seed, of the fruit, of the flower, &c.

The following table, in which we have placed the most important natural families, shows at a glance the successive degrees through which we arrive at the division of the vegetable kingdom, according to the *natural method* or classification of Jussieu :

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21. In what respects do *phanero'gamous* plants differ from each other ? How are *phanero'gamous* plants divided ?

22. How do *crypto'gamous* plants differ from each other ? How are they divided ?

23. On what principle are these divisions subdivided ?



# TABLE

OF THE

## CLASSIFICATION OF PLANTS,

ACCORDING TO THE NATURAL METHOD OF JUSSIEU.

CLASSES.

FAMILIES.

PLANTS.

|                                                 |  |                                            |  |             |  |       |  |
|-------------------------------------------------|--|--------------------------------------------|--|-------------|--|-------|--|
| Embry' onate or Phanero' gamous (Coty' ledons). |  | Cryptoga' mia or inembryonate--Acotyledons |  | Cellulares. |  | Algæ. |  |
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## CRYPTO'GAMOUS PLANTS.

*Division of Cryptoga'mia. (See table on page 102.)*

24. Crypto'gamous plants are constituted exclusively, or chiefly of cells, and during the first period of their growth, or even throughout their existence, are unprovided with vessels and stigmas; they also differ from phanero'gamous plants in their mode of propagation, for their multiplication always takes place without the aid of various reproductive organs, analogous to stamens and pistils, and is effected by the division or by the development of *sporules*, bodies which resemble the seeds of ordinary plants, but have no protecting envelope like a pericarp, nor a depot of nutritive matter similar to the albumen, or to coty'ledons. We divide these plants into two groups; *cellular plants properly so called*, and *semi-vascular plants*.

25. CELLULAR PLANTS properly so called are composed exclusively, and at all periods of their existence, of cellular tissue, which forms a homogeneous mass and is rarely green; their forms, which are very various, do not at all resemble those of ordinary plants; we can distinguish in these plants neither roots nor organs similar to stems or leaves, and absorption seems to take place throughout the whole extent of their surface. When their tissue is membranous and flat, we give the part thus constituted the name of *thallus*, and when branched and spread out, it constitutes what is called a *frond* or *frons*. The sporules are sometimes naked, sometimes contained in one or more membranous sacks which seem to be ordinary cells.

26. This group is divided into three natural families; Lichenes, Fungi, and Algæ.

27. LICHENS are perennial plants which grow upon the trunks of trees, on rocks, or on the surface of the ground, and are composed of a *thallus* (possibly from the Greek, *thaleia*, the blooming one) having the appearance of filaments, of foliaceous membranes or hardened pulve'ruent crusts. This thallus consists of two layers, one external or cortical, variously coloured, but never green; and an internal or medullary, which often contains green matter and gives origin to young plants, either by the division of its tissue or by the production of spores (from the Greek, *spora*,

24. What are the general characters of crypto'gamous plants? How do they differ from phanero'gamous plants? What are sporules? How are crypto'gamous plants divided?

25. What are the general characters of cellular plants? What is a thallus? What is a frond?

26. How are cellular plants divided?

27. What are lichens? What is the character of the thallus in lichens?

seed) called *apothecum* or *scutum* (Latin, a shield), because their form is frequently like that of a small shield.

28. There are more than two thousand species of lichens known; they grow in the most arid places, and constitute the greater part of the vegetation of the regions near the pole. One species, the *cenomyce range-ferina* (reindeer) (*cenomy'ce*, from the Greek, *kenos*, empty, and *mukes*, a minute fungus), forms the food of the reindeers of Lapland for the greater part of the year and several are used as dye-stuffs, as the archil.

29. The FUNGI, mushrooms, are plants of various forms, and are never green. In general, they consist of cellular tissue

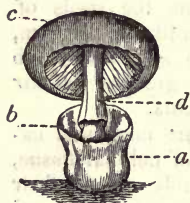


Fig. 128.—MUSHROOM.

formed into globular masses, or having a peduncle (*fig. 128, d*) surmounted by a cap, pileus (*c*), which is ordinarily convex, and the inferior surface is furnished with radiating laminæ (*fig. 128*). They are distinguished from lichens and algæ by the absence of *frons* or crust, bearing organs of fructification. The *sporules* are sometimes naked, and sometimes enclosed in little capsules; in common mushrooms, the union

of these capsules constitutes a membrane named the *hymenium* (from the Greek, *umen*, a membrane), which is ordinarily plaited, and covers, entirely or in part, the surface of the plant. These sporules become free, sometimes by the rupture of their envelope, sometimes by the decay of the tissue which surrounds them; and when they germinate, we observe arising from them white filaments upon which spring bodies, from point to point, that seemingly constitute the mushroom, but in reality they appear to be only the spores, that is, the reproductive organs. These plants are developed, in general, in shady, damp, and warm situations, and are found especially numerous where organic matters in a state of putrefaction abound; many live as parasites upon perennial plants, and some grow on the surface of water, but most of them inhabit the surface of the earth, or are buried in the soil; sometimes they grow with extraordinary rapidity; frequently we see thousands of mushrooms growing up in a single night, and the greater part of them do not live beyond a few days at most; there are some however that grow slowly and live many years.

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*Explanation of Fig. 128.*—A mushroom (fungus);—*a*, *b*, the volva or wrapper;—*c*, the pileus or cap;—*d*, the peduncle or stipe.

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28. How many species of lichens are known? To what uses are lichens applied?

29. What are the general characters of fungi? What is a hymenium? Where are fungi found?



30. This family is very numerous, and is divided into several groups, the most important of which are *agarics* or *mushrooms*, properly so called, *lycopodiaceæ*, and the *muscidineæ*, moss tribe.

31. *Agarics* or *mushrooms*, properly so called, are plants ordinarily of fleshy consistence, the sporules of which are placed on the surface of an external membrane and enclosed in distinct capsules. Some have a sort of stem surmounted by an umbrella-shaped cap, the inferior surface of which is lined by the sporiferous membrane; others are club-shaped or branched; others again form irregular masses of a gelatinous consistence. They are commonly found in shady, damp woods, at the foot of old trees, and a great many are known. Several of them may be used as food, and are even very much esteemed, but others are violently poisonous, and there are no general characters by which good mushrooms may be certainly distinguished from bad ones; it is only when we are able to recognise perfectly the species known to be good that we should venture to eat those found in forests, because there are poisonous mushrooms which so closely resemble the edible species that mistakes are easily made. We should invariably reject those which change colour quickly after being gathered; those which contain a milky juice, or are of a very soft and watery structure; those that have a peppery, bitter, or astringent taste, and disagreeable odour; a bright red colour is also frequently an indication of poisonous qualities.

32. The mushrooms most used as food are the edible agaric—*agaricus edulis*, the *mousserron agaric*, the *orange*, *chanelle*, *morille*, *ceps*, or *boletus edulis*, or edible bole; but the only species cultivated is the *edible agaric*, which is propagated at pleasure by means of the white filaments that spread out in the soil where the sporules have germinated, and are known to gardeners under the name of *white of mushrooms*.

33. One of the most poisonous mushrooms is the *false orange*, which resembles the true orange, which is among the most esteemed species, and is very common in the South of France.

34. *Tinder* or *spunk* is a species of mushroom of the genus *Agaric*.

30. What are the most important divisions of the family of Fungi?

31. What are agarics? How are edible mushrooms recognised?

32. What species of mushrooms are used for food? What species is cultivated?

33. Name one of the most poisonous species of mushroom.

34. What is spunk?

35. The division of the *Lycopodia'ceæ* comprises mushrooms, the sporules of which are not enclosed in especial capsules. We place among them *truffles* (fig. 129), singular plants of irregularly rounded form, which grow under ground without being attached to any other body and without ever appearing above the surface. The *edible truffle*, so much esteemed by *gourmands*, is of a brown colour, strong odour, and peculiar taste; its size varies from that of an egg to that of a fist, and it grows five or six inches under ground. It is chiefly met with in forests of ash, chestnut, or oak, and in soils composed of sand and clay. To gather these subterranean mushrooms we take advantage of the instinct of hogs, which root them up with their snout. They have not been multiplied by cultivation as yet.



Fig. 129.—TRUFFLE.

36. The *mucedineæ* or *moulds* are also plants of the family of Fungi, and we also place in this natural division certain parasitic plants that grow on other living plants, often producing in them very remarkable injurious alterations. Of this number is a species of fungus named *aredo*, which is sometimes developed on wheat, and occasions what farmers call *blight*.

37. The FAMILY OF ALGÆ—*Sea-weeds*—is composed of marine and other aquatic plants, the structure of which is very simple. The *fuci* which cover the rocks on our coast belong to this group. The genus *Fucus* (fig. 130) yields iodine, a useful medicine. The *Chondrus crispus* or *Carageen moss* of Ireland, which also grows on our own coast, is converted into size; it also yields a fine jelly for invalids, and is often used in the composition of *blancmange*.



Fig. 130.—FUCUS.

38. The SEMI-VASCULAR PLANTS are at first composed of cellular tissue alone like cellular plants, but often acquire, at a certain period of their development, vessels and stomata like phanerogamous plants. They are provided with roots like the latter,

35. What species of mushroom belong to the division of *Lycopodia'ceæ*? What are the general characters of the edible truffle? Where are they found? Are they cultivated?

36. What are *mucedineæ*? What is *aredo*?

37. What are Algæ? What do we obtain from the genus *Fucus*?

38. What are the general characters of the semi-vascular plants?



Fig. 131.—MOSS.

and with expansions or fronds, ordinarily green, analogous to leaves; the latter often arise from an axis similar to a stem, and sporules are developed upon their external or inferior surface.

39. In this division we place the mosses, *musci*, the ferns, *felices*, and some other families of less importance.

40. The MOSSES—*Musci*—(figs. 131 and 132) have a very short, herbaceous stem, fixed on the ground, on stones, or the bark of trees, by small brown roots, and covered by little leaves in form of scales; there are no vessels in their interior; finally, their spores are enclosed in lateral or terminal buds, surrounded by a sort of perigon, and arise from the internal parietes of a sort of urn (fig. 132). “Mosses rank among the smallest of plants;



Fig. 132.  
MOSS.

they seldom exceed the height of a few inches; and many are so minute that they would wholly escape our observation if they did not grow in patches. Several species, indeed, are scarcely visible to the naked eye; and yet they have a stem, leaves, fruit, and other organs, as the largest plants of the family.”—*Gray's Elements of Botany*.

41. The FERNS—*Felices*—(figs. 133 and 134) are herbaceous or arborescent plants, the fronds or leaves of which are alternate, often lobate, and grow upon a sort of vertical stem or rhizome; we find stomata on the leaves, and tracheæ and other vessels in their petioles. Their organs of fructification are found on the inferior surface of the leaves, towards the edge, at the extremity of the veins (fig. 133). “Although the ferns of the United States and of all northern climates have prostrate stems, and consequently do not



Fig. 133.  
FERN.

*Explanation of Fig. 132.*—A magnified view of the capsule of a moss, enclosing the sporules. The *sporule case*, or *theca*, also called capsule, is a little oblong urn-shaped body, which in a few cases is *sessile*, but is usually borne on a filiform *fruit stalk* or *seta* (fig. 131). The tall cap-like part of the figure above, somewhat like an extinguisher, is called a *calyptra*, and when of this form is said to be *mitriform*.

39. What families belong to the semi-vascular plants?

40. What are the general characters of the mosses?

41. What are the general characters of the ferns?





Fig. 134.  
FERN.

rise, at most, above three or four feet in height, yet in tropical countries their trunks are often erect, and frequently attain the height of seventy or eighty feet. The tree ferns of the tropics are said to be objects of incomparable beauty ; their straight, unbranched trunks often rising, like those of palms, as high as forty or fifty feet, without a leaf."—*Gray*.

42. We also place in this division of the vegetable kingdom the *chara* (fig. 135), an aquatic plant, which is very remarkable on account of the singular circulation observed in the interior of the cellules of its tissue. Of the structure of the *charæ* very little is certainly known. They consist of submersed water-plants, having slender jointed stems destitute of leaves, but furnished



Fig. 135.—CHARA.

with whorled branches resembling the stem. There are only a few species, but these abound in stagnant waters.

### PHANEROGAMOUS PLANTS.

43. This great division of the vegetable kingdom comprises all plants that bear flowers and are multiplied by means of true seeds. They are also called *cotyledonous plants*, because the embryo or germ, contained in the seed, is always provided with one or more cotyledons, organs which serve as depots of food for the nourishment of the young plant during the first part of its existence, and are not found in the cryptogamia. Vessels as well as cellular tissue always enter into the composition of these plants, and for this reason botanists sometimes designate them under the name of *vascular plants*.

They are divided, as we stated before, into two groups, the *monocotyledons* and *dicotyledons*.

### MONOCOTYLE'DONOUS PLANTS.

44. The most remarkable characteristics of the organization of plants of this division are :

*Explanation of Fig. 134.*—The leaf of a fern (magnified) seen from below, showing the capsules containing the sporules.

42. What are the characters of the genus *Chara*?
43. What description of vegetables belong to the division of phanerogamous plants?
44. What are the most remarkable characteristics of the monocotyledons?

1st. The existence of a single coty'ledon in the seed, a circumstance which corresponds with a particular mode of germination.

2d. The existence of an en'dogenous stem, that is, a stem in which the new fibres do not form concentric layers around the old, but are arranged in scattered bundles.

3d. The arrangement of the nerves of the leaves is almost always parallel; as in Indian corn.

4th. The existence of a single floral envelope, called *perianth* or *glume*, which takes the place of calyx and corolla.

45. These plants are also distinguished from the dicoty'ledons by their aspect and by some other characters. We place in this group the Grami'neæ, Palma'ceæ, Asparagi'neæ, Lilia'ceæ, Nar-cissa'ceæ, I'rideæ, Orchi'deæ, and several other natural families.

46. The FAMILY OF GRAMI'NEÆ — Grasses — (figs. 136 and 139) belongs to the class of monocoty'ledons with stamens inserted below the ovary, named for this reason, monohypogy'nia (from the Greek, *monos*, single, *upo*, below, and *gune*, woman, metaphorically, pistil, that is, having the stamens fixed below the ovary). They are for the most part herbaceous plants; their stem, which is cylindrical and ordinarily hollow, presents at different points knots from which the leaves arise; it is called a *culm* or straw. The flowers are generally united in a *spike* or in *panicles* (fig. 137); their ovary is simple, and the seed, sometimes naked, and sometimes furnished with an envelope named *glume*, is composed of an albumen or farinaceous perisperm, having a lateral pit near its base which lodges the embryo. It is this perisperm which renders many of these plants so useful, by furnishing to man an abundant and wholesome article of food, flour, and meal, &c.



Fig. 136.  
DARNEL.



Fig. 137  
DARNEL.

47. This family is composed of a great many genera, among

*Explanation of Fig. 137.* — A magnified flower of the darnel, *Lolium perenne*, sometimes called ray-grass, &c.

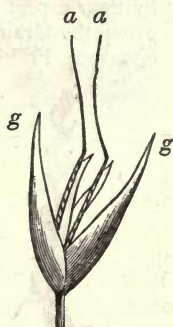
45. What natural families belong to the class of monocoty'ledons?

46. What are the general characters of the grasses? What is a *culm*?

47. What genera belong to the family of Grami'neæ?

which are wheat, rye, barley, oats, maize (Indian corn), rice, and sugar-cane, as well as bamboo and reeds. We also place in this family different herbs which constitute the bottom-grass of all natural prairies, such as fescue, alopecurus (from the Greek, *alopez*, a fox, and *oura*, tail, fox-tail), timothy, festuca, meadow-grass, and darnel or tare (*fig. 136*).

48. Common wheat — *Triticum* — the most important of all the grasses, is an herbaceous annual plant, with a stem (culm) four or five feet high, furnished with some leaves, which is terminated by a spike composed of flowers united in groups of from three to six, called *spikelets*, in a common envelope, which consists of two scales, bearing the common name of *glume*; each flower bears three stamens enclosed between two unequal paleæ (from the Latin, *palea*, chaff), the external of which often but not always terminates in a long beard or barb, called *awn* (*fig. 138 a*). The seed is oval, larger than that of most other grasses, convex on one side, and on the other hollowed by a longitudinal groove; on an average, there are forty seeds on each spike. It is filled by a white, farinaceous substance, chiefly consisting of *fecula*, and a peculiar substance named *gluten*. These two substances, crushed by a mill-stone, constitute the flour which we use for making bread. *Fecula* consists of minute grains, filled with a matter of a gummy consistence, which, by the action of heat and various chemical agents, burst and permit their contents to escape; this is the reason why, when we boil *fecula* in water, it suddenly thickens and becomes paste. *Gluten* is a very elastic substance, which may be separated from *fecula* by washing wheat flour, wrapped in a cloth, under a stream of water, for some time.



*Fig. 138.*—GLUME.

49. Wheat is sown at two different periods; in the autumn

*Explanation of Fig. 138.*—The glume or husk;—*a, a*, the awns;—*g, g*, the glume. This term is most generally applied to the outer and thicker set of scaly leaves next to the sexual organs in grasses, two in number, and embracing each other at the base (*fig. 138*), in which are seen the outer scales (glume or calyx, *g, g*) and the inner scales with the awn (*a*) attached. The stamens and pistils are removed. The small thin leaves to which the awns are attached, are called *paleæ*. When these scaly leaves embrace several flowers, they are called bractæ (bracts).

48. What are the characters of wheat? What is a glume? What is meant by the paleæ? What is *fecula*? What is *gluten*?

49. What is the difference between fall and spring wheat?



and in the spring; the first is called winter or “fall” wheat, and the second spring wheat; the season of the harvest varies according to the climate.

50. There is a species of wheat called *spelt*, the seeds of which are not separated from their envelope by thrashing, and still another called dog or couch-grass, having a long spreading root, which is very injurious on account of the rapidity with which it overspreads wheat-fields.

51. *Common rye—Secale*—very much resembles wheat, but it never has more than two flowers joined in the same glume, and forming a spikelet. It is said to have come originally from the Levant, but is cultivated in the United States and all parts of Europe; it succeeds better than wheat in cold countries, and in dry and arid soils. It is sown earlier than the other cereals, and generally flowers in the month of May; and it is usually gathered fifteen or twenty days before the wheat (generally in the month of July). Rye flour is not so white as that of wheat, but is used for the same purposes.

52. *Barley—Hordeum*—is distinguished from the preceding species by its simple, compact spike, formed of spikelets of a single flower, arranged three and three; its height does not exceed two or three feet. It is the easiest of the cereals to cultivate, and the most rapid in its development; but barley flour is even less nourishing than rye. What is called *pot barley* is made by grinding off the husk, and *pearl barley* is made by carrying the operation so far as to produce roundness of the grains.

Malt is the chief purpose for which barley is cultivated in Great Britain and the United States. In order to understand the process of malting, it may be necessary to observe, that the cotyledons of a seed, before a young plant is produced, are changed by the heat and moisture of the earth into sugar and mucilage. Malting is only an artificial mode of effecting this object, by steeping the grain in water, and fermenting it in heaps, and then arresting its progress towards becoming a plant, by kiln-drying it, in order to take advantage of the sugar in the distillation of spirits, or fermentation for beer.

53. *Oats—Avena*—has its flowers arranged in an open panicle, composed of multiflorous spikelets hanging on their peduncles. The seeds adhere to the glume, and are oblong and acute; they are much used as food for horses. Oats are sown in the autumn or spring, and are gathered from the middle of July to the first of September. The flour, called oat meal, is also made into bread, and forms what is termed groats by grinding off the husk.

50. Are there other kinds of wheat?

51. What are the characters of rye?

52. How is barley distinguished from wheat and rye? What is the difference between pot and pearl barley? What is malt?

53. What are the characters of oats?

54. *Rice*—*Ory'za*\*—also has flowers arranged in a panicle, but the spikelets are uniflorous; it is an annual plant, and delights most in low humid situations, and even in inundated places; its culm rises three or four feet high, and its leaves are very long. It is originally from India: it is cultivated in Italy, but Asia, Africa and America furnish most; Carolina rice is considered amongst the very best; it constitutes the principal article of diet of all the nations of the East.

55. *Maize*, or *Indian Corn*—*Zea*—(from the Greek, *zeò*, I live)—is also an herbaceous annual grass; its fibrous roots give rise to one or more stems five or six feet high, the summit of which bears a panicle nearly a foot long, formed of male flowers in great numbers on several spikes; the female flowers are very numerous, sessile, attached upon a common axis in the axil of the superior leaves. The grains are rounded, of the size of a common pea, ordinarily of a yellow colour, compressed one against the other, and arranged longitudinally in six or eight rows. This plant is originally from America; but was long ago introduced into Europe, and is cultivated in all the south of France, Spain and Italy, and is used as food both for men and many domestic animals.



Fig. 139.—SUGAR-CANE.

56. *Sugar-cane*—*Saccharum*†—(fig. 139)—also belongs to the family of Grami'neæ; its white, silky flowers, all of which are hermaphrodite, are arranged in fasciculated spikes, with two flowers at each articulation; its stem, which is from eight to twelve feet high, is full of sweet juice, which, being compressed and evaporated by boiling, yields sugar. It grows in the East and West Indies, United States, South America, and South Sea Islands.

\* *ORY'ZA*.—From the Arabic word *eruz*, the Greeks coined their word *oruza*, and the various modern nations of Europe, their *rice*, *riz*, *reis*, *arrôz*, &c.

† *SACCHARUM*.—From its Arabic name *soukar*, from which the Greeks

54. What are the general characters of the rice plant?

55. What are the characters of Indian corn?

56. What are the characters of sugar-cane? How is sugar made? How is sugar-candy prepared? What is rock-candy? What is barley-sugar? What is rum?

[The cane in the West Indies is propagated by cuttings from the root end, planted in hills or trenches in spring or autumn, something in the manner of hops. The cuttings take root at the joints under ground, and from those above send up shoots, which, in from eight to fourteen months, are from six to ten feet long, and fit to cut down for the mill. A plantation lasts from six to ten years. Sugar mills are merely iron rollers placed vertically or horizontally, between which the canes are passed and repassed. The juice thus squeezed out is collected and boiled with quicklime, which imbibes the superfluous acid, which otherwise would impede crystallization: impurities are skimmed off, and the boiling is continued till a thick syrup is produced, when the whole is cooled and granulated in shallow vessels of earthen ware, which permit the molasses (a part that will not granulate) to drain off. It is now the brown or raw sugar of commerce. A further purification is effected by dissolving it in water, boiling, skimming, adding lime, and clarifying from the oily or mucilaginous parts, by adding blood or eggs, which incorporate with them and form a scum. When boiled to a proper consistency, it is put into unglazed earthen vessels of a conical shape, with a hole at the apex, but placed in an inverted position, and the base, after the sugar is poured in, covered with clay. When thus drained of its impurities, it is taken out of the mould, wrapped in paper, and dried or baked in a close oven. It is now the loaf sugar of the shops, and according to the number of operations it undergoes, is called single or double refined. The operation of refining is seldom or never performed by the growers, but forms a separate branch of business.

*Sugar-candy* is formed by dissolving loaf sugar in water over a fire, boiling it to a syrup, and then exposing it to crystallize in a cool place. When crystallized upon strings put into the syrup, it is called *rock-candy*. This is the only sugar esteemed in the East.

Barley-sugar is a syrup from the refuse of sugar-candy, hardened in cylindrical moulds.

Rum is distilled from the fermented juice of sugar and water.]

57. The *Bamboo*—*Bambu'sa*—(from the Indian name *Bambos*)—an arborescent plant of the equatorial regions, also belongs to the family of Grami'neæ. The bamboo is applied to a great variety of purposes. In India it is used for building houses and bridges, for masts, for boats, for making boxes, baskets, cups, mats, tables, chairs, fences, paper, and a variety of other purposes; and the tops of the tender shoots are, in the West Indies, pickled. It grows about forty feet high. The *genus* *Bambu'sa*, belongs to the *class* Hexandria, *order* Monogy'nia of Linnæus.

58. The FAMILY OF PALMS—*Palma'ceæ*, (*fig.* 140)—is composed of monocoty'ledons with perigy'nous stamens; the stem, which is cylindrical and resembles a column, is crowned by a fasciculus of large leaves. We have already spoken of its structure (*page* 26). Their flowers, which are generally unisexual,

formed *sackchar*, and modern European nations sugar. The *genus* *Saccharum* belongs to the *class* *Tria'ndria*, *order* *Trigy'nia*, of the Linnæan arrangement.

57. What is bamboo? To what uses is it applied?

58. How is the family of Palms characterized? What is sago?



form catkins or a great bunch called *raceme*; the fruit is a fleshy or fibrous drupe containing a very hard, bony nut. Nearly all these large and beautiful trees belong to the inter-tropical regions; many of them furnish the inhabitants of the countries in which they grow naturally, wholesome and pleasant food; the date tree and cocoa-nut yield excellent fruits; the cabbage-tree palm bears a terminal bud which may be compared to our common cabbage, and several other species yield a fecula named *sago*. By incision into the spathe at the top of the stems of some, a saccharine liquor, termed *sweet toddy*, is procured, which when fermented constitutes *Palm wine*, and yields by distillation *arrack*, or *rack*. The date tree—*Phoenix*—(the Greek name of the



Fig. 140.—DATE PALM.

date)—furnishes a great part of the diet of the inhabitants of Arabia and part of Persia. They make a conserve of it with sugar; and even grind the hard stones in their handmills for their camels. The leaves are manufactured into baskets, bags, brushes, &c., and the stem is used in building, and another part of the plant is made into rope and rigging for small vessels.\* The palms of Scripture are the leaves of the date tree.

The genus *Calamus* (from the Greek *kalamos*, a reed) furnishes the several species of rattan-canes, whose flexible stems when split are woven into chair-bottoms.

59. The FAMILY OF ASPHODE'LEÆ, or Asparigi'næ, belongs to the class of Monoperigy'nia, and is composed of herbaceous plants with fibrous roots, the fruit of which is a capsule with three cells, or a globular berry. *Common asparagus*, the young shoots of which are eaten, is the type of this group.

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\* The *Phoenix*, according to the Linnean arrangement, is in the class *Diœcia*, order *Triandria*; while the *Calamus*, another genus of the *Pal-maceæ*, is in the class *Hexa'ndria*, and order *Monogy'nia*.

What is sweet toddy? What is arrack? What tree furnishes dates? What are rattans?

59. What are the characters of the *Asphode'leæ*?

60. The FAMILY OF LILIA'CEÆ is also placed in the class of Monoperigy'nia; it is composed of plants with bulbous or fibrous roots, and a stem (or shaft) generally naked; the leaves are sessile or sheathing; several species of this family are remarkable from having flowers with a coloured calyx, such as the *lilies*, *tulips*, *hyacinths*, *tuberoses*, *imperials*, &c.

61. The FAMILY OF AMARY'LLIDÆ or NARCI'SSEÆ (*fig. 141*), and the family of IRI'DEÆ belong on the contrary to the Mono-epigy'nia: among the first is the common Narcissus (*fig. 141*), the *Agave americana*, and among the second the *Iris florentina*, which furnishes orris root, and the *Crocus sativus*, which has long, orange-coloured stigmas, which, when dried, form saffron. The plants of the family of Iri'deæ are herbaceous — under shrubs, with fibrous or bulbous roots; generally their flowers are large, beautiful, and variegated in different colours.



*Fig. 141.*—NARCISSUS.

#### DICOTYLE'DONOUS PLANTS.

62. The plants of this division are chiefly characterized:
- 1st. By the existence of an embryo with two cotyledons; sometimes however we find three, or even more.
  - 2d. By the internal organization of the stem, all parts of which are arranged in concentric layers, the growth of which is ex'ogenous.
  - 3d. By the arrangement of the leaves, the nerves of which are ramified.
  - 4th. By the very frequent presence of both a calyx and a corolla, &c.
63. They are divided into four groups; the Apeta'leæ, Mono-peta'leæ, Polypeta'leæ, and Dicli'neæ.

- 
60. What are the characters of the Lilia'ceæ?
61. To what family does the common narcissus belong? What is orris root? What is saffron?
62. What are the chief characters of the dicoty'ledons?
63. How is the division of dicoty'ledons divided?

## APETALOUS DICOTYLEDONS.

64. This group of dicotyledonous plants is characterized by the absence of a corolla, or at least of a double floral envelope, for the perianth as often resembles a corolla as a calyx. We place in it *Aristolochia*, *Laurineæ*, &c.



Fig. 142.

65. The FAMILY OF ARISTOLOCHIA — *Birthwort* — (from the Greek, *arisos*, excellent, and *lochos*, female, because it was supposed to be excellent for females in particular conditions) is composed of twining plants with epigynous stamens (figure 142), with alternate and internal



Fig. 143.

ARISTOLOCHIA.

leaves, some species of which are cultivated in gardens—the common *Aristolochia*, for example (fig. 143). The *Aristolochia serpentaria*—Virginia snake-root—belongs to this family.

66. The FAMILY OF LAURINEÆ (from the Latin, *laurus*, the laurel or bay tree) belongs to the class of Peristamineæ (from the Greek, *peri*, around, and *stamen*—fig. 144), and is composed of trees or shrubs with persistent leaves and fleshy fruit. The type of the family is the *laurels*, one species of which, the laurel of Apollo, is originally from Greece, and was used by the ancients for decorating the crowns of their conquerors. *Cinnamon* is the bark of another species of laurel which grows in India; and *camphor* is derived from another tree of the same genus.

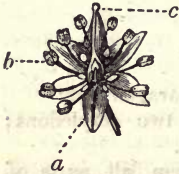


Fig. 144.—LAURUS.

67. We will also mention in this class the FAMILY OF CHENOPODEÆ (from the Greek, *chen*, a goose, and *pous*, foot—goose-foot), because we find in it one of the plants which at present occupies a good deal of attention among agriculturalists, espe-

*Explanation of Fig. 144.*—Flower of a laurel;—*a*, the perigon;—*b*, stamen;—*c*, pistil.

64. How are Apetales characterized?

65. How is the family of *Aristolochia* (pronounced *aristolokea*) characterized?

66. From what is cinnamon obtained? From what genus of plants is camphor derived?

67. To what family does the sugar-beet belong?



cially in France; namely, the *sugar-beet*. This plant, originally from the southern parts of Europe, is annual or biennial; it has a spindle-shaped, fleshy root, sometimes as thick as one's leg, which contains a considerable quantity of sugar, precisely like that of the sugar-cane; the leaves of the sugar-beet constitute an abundant and wholesome food for cattle, but it is especially cultivated in France for its sugar.

### MONOPETALOUS DICOTYLEDONS.

68. This division, which is much more numerous than the preceding, is characterized by having a corolla distinct from the calyx, and composed of a single piece. In it we place the *Sola'neæ*, *Primula'ceæ*, *Jasmi'neæ*, *Labia'tæ*, *Synanthe'reæ*, and *Rubia'ceæ*, &c.

69. The FAMILY OF SOLA'NEÆ is composed of monopetalous, dicotyledonous plants with hypogynous stamens, the flowers of which have a monosepalous, persistent calyx, with five lobes, a regular corolla, divided into from four to five lobes, four or five stamens, and a style bearing a stigma with two lobes, the fruit of which is a capsule or a berry containing a great many seeds, and the leaves are commonly alternate. Most of the *Sola'neæ* contain a narcotic (stupifying) substance, which sometimes renders them very dangerous; tobacco, henbane, stramonium (Jamestown weed), are of this kind; we find it even in the leaves of the common night-shade, and the *Solanum tuberosum*. This last plant, the stem of which is herbaceous, and the flowers white or slightly violet, has at irregular intervals on its long, fibrous roots, large tubers, which are ordinarily rounded or oblong, which contain an immense quantity of fecula, and are known under the name of *potatoes*.

The potatoe is originally from America (growing at this time wild in Mexico and Peru), and was first introduced to Europe by Sir Walter Raleigh, about the year 1587, who carried it to England, whence it was soon spread upon the continent; it is now cultivated in almost every part of the world. This plant may be reproduced, multiplied in two ways; namely, by the seed, or by the development of the root-buds or *eyes*, which we see on the surface of the tubers. By sowing the seed we obtain a great variety; but the multiplication by the root-buds produces, without any alteration in the form or colour, potatoes like those from which the tubercles were taken. This last mode of culture is most generally used, and to succeed, it is only necessary to place entire tubers in the ground; we may divide them into several pieces, provided each fragment has one or more root-buds upon it, for the development of which the feculent matter of the

68. How are the Monopetales characterized?

69. What are the general characters of the *Sola'neæ*? What plant produces potatoes? Where were potatoes originally found? How are they cultivated?

potatoe furnishes the nourishment. In those countries where frosts are feared in the spring, these vegetables are planted about the month of April, and gathered towards the end of October; a sandy and rich soil suits them best; in moist clayey land they become pasty. By the ordinary method of cultivation, the potatoe yields but seven or eight for one, but by hoeing the stems, that is, by heaping up the earth to a certain height around them, we obtain twelve or thirteen for one, and we are assured that by bedding and covering them with earth the product may be increased to sixty for one.



Fig. 145.—TOBACCO.

70. *Tobacco*—*Nicotiana tabacum*—(fig. 145) is a plant of the genus *Nicotiana*, which is a native of America; it is actively cultivated for its large leaves, the uses of which are known by every body. Introduced into the stomach it acts as a poison, and the smoke it yields when burnt commonly excites nausea and giddiness in persons not accustomed to it; but they may become readily habituated to its use, which, either in the form of snuff, cigars, or smoking and chewing tobacco, has become almost universal. It is now cultivated in France, and in most countries of Europe, and several parts of India, as well as in various parts of America. It is sown about the month of March; and about the middle of July, they begin to gather

the leaves; this harvest continues until the period of frost, which the plant does not resist, and after drying the leaves thus obtained, and having removed from them the large nerves (stems), they are sprinkled with salt and water, and for a certain time permitted to ferment; tobacco for smoking is then coarsely cut up, and exposed to a moderate heat which curls it; tobacco for snuff is cut into strips, which are pressed into masses, which are afterwards reduced to powder by a mill.

71. *Belladonna*—*Atropa belladonna*—is another plant of the family of Solanæ which is also very poisonous; it is common under walls and in the woods. Its stem is branching, three or four feet high, and slightly hairy; its leaves are large, ovate, acuminate, and diffuse a disagreeable odour; its corolla, in form of an elongated bell, has five lobes, is of a dull red; its fruit is fleshy,

70. Where is tobacco found? What are its qualities?

71. What are the properties of belladonna?

about the size of a cherry, at first green, then reddish, and lastly black. It then resembles a black-heart cherry; its taste is insipid, but this fruit is extremely poisonous. The henbane (*hyosciamus*), bitter-sweet (*dulcamara*), and several other plants of the same family are also active poisons.

72. The FAMILY OF JASMI'NÆ, also, belongs to the class of the Hypocoro'llææ, and is composed of trees and shrubs with, commonly, opposite leaves; the corolla of the flower has four or five lobes, but only two stamens (*figs.* 146, 147). We place in it the jasmine, olive, ash, &c.



Fig. 146.  
JASMIN.



Fig. 148.—BRANCH OF OLIVE.

73. The *Olive*—*Olea europæa*—(*fig.* 148)—is a tree originally from Asia Minor, and the south of Europe, now extensively cultivated in the southern departments of France; in the East it grows from forty to fifty feet high, but in France it rarely exceeds twenty-five. It is extremely long-lived. Its leaves are opposite, lanceolate, of a bronze green colour above, and whitish below. Its flowers are small and arranged in little clusters (*fig.* 149); its fruit is a fleshy, oval drupe, contain-



Fig. 147.  
OLIVE  
FLOWER.



Fig. 149.  
OLIVE.

ing a nut with a single seed. A symbol of peace, and consecrated to Minerva, this tree was an object of a species of worship among the Greeks, and its destruction was prohibited under severe penalty: it is still cultivated with care, but for other reasons—its fruit and its oil. (Olive, or *sweet oil*, may be said to form the cream and butter of Spain and Italy. *Olive oil* is made by crushing the fruit to a paste, then pressing it through a woollen bag, adding hot water as long as any oil is pro-

72. To what class does the family of Jasmi'næ belong?

73. What are the general characters of the olive tree? How is sweet oil prepared? What is the difference between French and Spanish olives?



duced. The oil is afterwards skimmed off the water, and put in tubs, barrels, and bottles for use. *Pickled olives* are prepared from unripe fruit, by repeatedly steeping them in water, to which quicklime or any alkaline substance is sometimes added to shorten the operation. Afterwards they are soaked in pure water, and then taken out and bottled in salt and water, with or without an aromatic. *Spanish olives* differ from the French in consequence of being prepared from ripe fruit.)

74. The *Ash*—*Fraxinus*—is among the largest and most beautiful forest trees; it delights in a humid, light soil; its wood, which is white, longitudinally veined and very pliant, is much employed in carriage-building, &c.

75. The *Manna-ash*, or *round-leaved ash*—*Fraxinus ornus*—which grows in Calabria, and on the coast of Africa, permits a sugar-like substance to exude through its bark, which hardens in the air, and is known under the name of *manna*.



Fig. 150.—SCARLET SAGE.



Fig. 151.—SAGE.

76. FAMILY OF LABIA'TÆ (*figs. 150 and 151*) belongs to the same division as the preceding: these plants, which are almost all herbaceous, have a square stem and a tubular corolla, divided into two lips, one of which is superior to the other (*fig. 151*); the fruit is composed of four monospermous acheniums enclosed in a persistent calyx, and the leaves are sessile and opposite. Most of the Labia'tæ are very aromatic; they are employed in medicine, and for the preparation of scented waters; such are the mint, lavender, rosemary, sage, thyme, balm, &c.

74. What use is made of the ash?

75. From what tree is manna obtained?

76. What are the general characters of the family of Labia'tæ?



Fig. 152.—CONVO'LVULUS.



Fig. 153.—MARIGOLD.

The FAMILY OF BORRAGI'NEÆ is closely allied to the Labia'tæ; the type of this family is the *borrage*.

77. The FAMILY OF CONVULVULA'CEÆ, which is also composed of hypogy'nous, monopetalous plants, has the *bindweeds* as its type (*figure 152*), which are common in our fields and gardens. A species of the bindweeds furnishes *jalap*, an active purgative medicine.

78. We also place in the class of Hypocoro'lleæ the FAMILY OF PRIMULA'CEÆ, the type of which is the primrose, the gentia'næ, and several others.

79. The FAMILY OF SYNANTHE'REÆ (from the Greek, *sun*, with, and *anthos*, flower) or COMPOSITÆ, which belongs to the division of monopetalous Epicoro'lleæ, is very remarkable for the arrangement of its flowers. They are generally small, and united in a close mass, called *capitulum*, upon a common receptacle; they are of two kinds; one has a regular corolla in form of a funnel, and called *flosculous*; the others have an irregular corolla, laterally warped in form of a little tongue. Finally, the anthers are united, and form a tube which is traversed by the style (*figure 110*).



Fig. 154.  
MILK THISTLE.

Sometimes the *capitulum*s (*fig. 80*) are composed only of florets like the thistle (*fig. 154, a*) and artichoke; sometimes in demi-florets, as the *dandelion* and *lettuce*; and sometimes of florets in the centre, and demi-florets occupying the circumference, as the *sunflower* and *marigold* (*fig. 153*). The first are frequently designated under the name of *flosculous*, the second are called *semi-flosculous*, and the last *radiate*.

77. From what family of plants is *jalap* obtained?

78. To what class does the family of Primula'ceæ belong?

79. What are the general characters of the Synanthé'reæ?

80. Other monopeta'leæ with epigy'nous corollæ, have the anthers distinct, and form the class named *Corisanthe'reæ*, which is divided into several families, among which are the *CAPRIFOLIA'CEÆ*, of which the honeysuckle is the type, and the *RUBIA'CEÆ*, a group in which we find the coffee, Peruvian bark, and ipecacuanha, &c.



Fig. 155.—COFFEE.

81. The *Coffee tree* (figure 155) appears to be originally from Ethiopia, whence it was carried by the Arabians to different parts of Arabia, but particularly to the province of Yemen, and especially to the environs of Mocha. Towards the close of the seventeenth century, the Dutch carried it to Batavia, and about 1710, one of these precious plants was sent from this colony to Amsterdam; it was carefully cultivated in the botanical garden, and soon produced fruit, the seeds of which furnished the means of its rapid multiplication, for one of these young trees thus obtained, having been sent to Louis XIV., flourished in the garden of plants, near Paris, and afforded the French govern-

ment the means of introducing its cultivation into Martinique; it soon spread through the West Indies, and Brazil, &c. The trunk of the coffee tree is cylindrical, and rises to from fifteen to twenty feet high; its branches are somewhat knotty; its leaves are lanceolate, shining, and of a deep green; its flowers are white and almost sessile; and its fruit is fleshy, ovoid berries, which are at first green, then red, and finally black; each berry encloses two fleshy nuts, each containing a seed convex outwardly and flat within, and marked on the flat side by a longitudinal groove. This shrub ordinarily flowers twice a year, but there is scarcely an interval between these periods, so that it is always loaded with flowers and fruit; the latter generally ripens four months after inflorescence, and must be gathered with care according to its state of maturity.

80. To what class do the families *Caprifolia'ceæ* and *Rubia'ceæ* belong?

81. What are the characters of the coffee tree? Where does it grow?



82. The plant which furnishes us the medicine called ipecacuanha, used as an emetic, bears considerable analogy to the coffee tree, and is found in South America.

83. The Cinchona or Peruvian bark, so valuable in the treatment of intermittent fevers, is the bark of certain trees which also belong to the family of Rubia'ceæ; they grow in Peru.

### POLYPE'TALOUS DICOTY'LEDONS.

84. This division is distinguished from the two preceding by having flowers, the corolla of which is composed of several separate petals. It is also divided in accordance with the insertion of the stamens into three sections called *Epipeta'leæ* (*epi*, upon), *Hypopeta'leæ* (*hypo*, beneath), and *Peripeta'leæ* (*peri*, around), which, in their turn, are subdivided into families, the most remarkable of which are the Umbelli'feræ, the Malva'ceæ, the Gerana'ceæ, the Aurantia'ceæ, the Papavera'ceæ, the Caryophy'llææ, the Ampe'lidæ, the Cucurbita'ceæ, the Myrta'ceæ, the Rosa'ceæ, the Legumino'sæ, the Terebintha'ceæ, &c.



Fig. 156.—HEMLOCK.

82. Where does ipecacuanha grow?

83. To what family does Peruvian bark belong?

84. What are the general characters of the polypetalous dicoty'ledons? How are they divided?

85. The FAMILY OF UMBELLI'FERÆ is composed of plants of the class Epipeta'leæ, the flowers of which are very small, and arranged in an umbel. One of the most remarkable genera of this group is that of the *hemlocks* (fig. 156), the poisonous action of which is very powerful. Several species are known; the spotted hemlock—*Coni'um macula'tum*—has a cylindrical, fistulous stem, longitudinally striated, branching, and marked at its inferior part with irregular spots of a dark purple, which are also seen on the leaves; these are very large, three-lobed, and of a very deep green; the whole plant diffuses a strong odour, especially when rubbed between the fingers. This hemlock is biennial, and grows in stony places, near hedges.

86. The *Carrot*, *Fennel*, *Angelica*, *Anis*, *Assafetida*, *Ammoniac*, *Galbanum*, and several other plants which are not at all poisonous, belong to this family.



Fig. 157.—MARSH MALLOW.

87. The FAMILY OF MALVA'CEÆ, the type of which is the marsh-mallows (figure 157), belongs to the class of Hypopeta'leæ; its principal characters are a monosepalous calyx with from three to five divisions, and a corolla with five petals adhering, at their base, to the filaments of the stamens, which are united into a tube (fig. 110). The uniform character of the mallow tribe is to abound in mucilage, and to be totally destitute of all unwholesome qualities.

88. The most important plants of this family are the *cotton trees*, the fruit of which furnishes the textile (weaveable) material, known under the name of *cotton*. Many species of this genus are known: one called *herbaceous cotton*, varies much in its appearance; sometimes it is an herbaceous annual plant growing scarcely beyond eighteen or twenty inches in height; at other times a shrub from four to six feet high, the stem of which is ligneous and perennial at its lower part. This cotton tree grows in Egypt, Syria, and

85. What are the general characters of hemlock? To what class and family does it belong?

86. Name some of the plants of this family.

87. How is the family of Malva'ceæ characterized?

88. What is cotton? What part of the plant furnishes cotton? How is the cotton wool separated from the seeds?

India, and is also cultivated in Sicily. The *arborescent cotton tree* was originally from India: it is now cultivated in Brazil and Peru, and constitutes one of the most important products of the United States: it grows to the height of from fifteen to twenty feet. The leaves of these plants are alternate, petiolate, and divided into five digitate lobes; the flowers, borne upon peduncles in the axils of the upper leaves, are yellowish or purplish. The fruit is an egg-shaped capsule, divided into from two to five cells, each of which contains several seeds; the cotton is found surrounding these seeds.

The *Gossypium herba'ceum*—herbaceous cotton—"grows from four to six feet high, and produces two crops annually; the first in eight months after sowing the seed; the second within four months after the first; and the produce of each plant is reckoned at about one pound weight. The branches are pruned or trimmed after the first gathering; and if the growth is over luxuriant, this should be done sooner. When a great part of the pods are expanded, the wool is picked, and afterwards cleared from the seeds by a machine (invented by Whitney, an American) called a cotton-gin, composed of two or three wooden rollers of about one inch diameter, ranged horizontally, close and parallel to each other; and the central roller being moved by a treadle or foot-lath, resembling that of a knife-grinder, makes the other two revolve in contrary directions. The cotton is laid in small quantities at a time upon these rollers, whilst they are in motion, and readily passing between them, drops into a bag placed underneath to receive it, leaving the seeds, which are too large to pass with it, behind. The cotton thus separated from the seeds, is afterwards hand-picked and cleansed thoroughly from any little particles of the pods or other substances which may be adhering to it. It is then stowed in large bags, where it is well trodden down, that it may be close and compact; and the better to answer this purpose, some water is every now and then sprinkled upon the outside of the bag; the marketable weight of which is usually three hundred pounds."—*Loudon*.

89. The *Flax*—*Linum usitatissimum*—which is employed in a like manner, belongs to another family of the same class, called the family of GERANIA'CEÆ, the type of which is the *Geraniums* of our gardens and green-houses. This well-known thread or clothing plant has been cultivated from the remotest antiquity for its cortical fibres, which, when separated from the woody matter, form the lint and tow, which is spun into yarn, and woven into linen cloth. Flax-seed yields a valuable oil, by expression, called linseed oil, used in painting; in powder it is much used for poultices; and the refuse, after pressing for oil, forms a cake fit to fatten cattle, and for manure. The stem of the flax is simple and cylindrical, from two to three feet high, and branching only towards the top; the leaves are sparse and lanceolate, and the terminal flowers are of a delicate blue; the calyx has five sepals,

89. To what family does the flax plant belong? What is linen? What is linseed oil?



and the corolla, which is campanulate, is composed of the same number of petals, and encloses five stamens, and as many stigmas.

90. The FAMILY OF AURANTIA'CEÆ or HESPERI'DEÆ, which includes the orange and lemon, belongs to the same class as the two preceding, and is composed of trees or shrubs, bearing articulate leaves, furnished with small vesicular glands, filled with a transparent volatile oil; their flowers are composed of a monosepalous persistent calyx, with from three to five divisions, and a corolla with from three to five petals; the style is simple; and the fruit is fleshy, internally separated by very thin membranous partitions, and covered by a thick pericarp, which, like the leaves, is furnished with vesicles filled with a volatile oil.

91. The *common orange* — *Ci'trus auran'tium* — is a tree which may grow to thirty or forty feet in height, but in our climate seldom attains to twenty feet. It does not resist the cold of our winters, and during this season it must be protected by a proper temperature. Orange trees do not often yield fruit after they are twenty years old; but they may live for centuries; there are orange trees still existing at Cordova, that date back to the time of the Moorish kings; one of these trees is said to be between six and seven hundred years old. At Versailles, there is a bitter orange tree, that, it is said, was sown in the year 1421, in the garden of the Queen of Navarre, at Pampeluna; it afterwards belonged to the Constable of Bourbon, and after his death, this tree, then the only one in France, was transported from Chantilly to the chateau of Fontainebleau, whence Louis XIV. carried it to the orangery of Versailles in 1684.

92. The uses of the orange, the lemon (*Ci'trus me'dica*), the citron (a variety of the *Ci'trus me'dica*), the lime (*Ci'trus acida*), and the shaddock (*Ci'trus decumana*), are well known. They all contain an agreeable acid, which renders them favourites as dessert fruits, or for making acidulous drinks, for preserves, confections, &c. The rind is generally bitter, and abounds in volatile oil. There are two principal varieties; the sweet or China orange, and the bitter or Seville orange. An agreeable distilled water is prepared from the flowers of the orange. The oil of bergamot is obtained from the rind of the fruit of a species of Citrus.

90. What are the characters of the family of Aurantia'ceæ?

91. To what family does the orange tree belong? Are orange trees very short-lived?

92. What are the uses of the orange?

93. Most botanists place in this family the *tea-plant* (fig. 158) — *Camellia* — (from *Camellus* or *Kamel*, the name of a Jesuit botanist). This remarkable genus furnishes the domestic tea in universal use, and flowering trees and shrubs which are universally admired. There are two species, the *Camellia bohe'a*, and the *Camellia viridis*, which furnish tea. This article is prepared with great care, and considerable labour. The leaves are carefully picked one by one; dried in shallow, iron pans, over a slow fire; exposed to the air, frequently turned, and finally passed through a winnowing machine, such as is commonly used by our farmers for wheat, &c. In this way the kinds of tea are separated, the lightest falling farthest from "the fan;" the first and the heaviest is the "imperial," next the young hyson, then gunpowder, and so on.



Fig. 158.—TEA-PLANT.

Both green and black tea are said to be from the same plant; but the green tea is longest over the fire. — *Ruschenberger's Voyage round the World*.

94. The VINI'FERÆ, or VITES, or AMPELLI'DEÆ, form another natural family closely resembling the preceding, which belongs to the same class; it is composed of bushes or sarmentous (trailing or climbing) shrubs, which support themselves by tendrils growing in the place of the peduncles; with simple or digitate, alternate leaves, having two stipules at the base, and small greenish flowers arranged in racemes opposite to the leaves; calyx very short, and the corolla composed of five petals, and five stamens opposite to the petals; the fruit is a globular berry containing from one to four seeds. Annexed are representations

Fig. 159.  
VINE.Fig. 160  
VINE.

93. To what family does the tea-plant belong? What is the genus of the tea-plant? Where does it grow?

94. What are the characters of the family Viniferæ? How many species of vine are cultivated in France? What are raisins? What are currants?

of the flowers of the vine. Figure 159 is the unexpanded flower magnified. The *Common vine*—*Vitis vinifera*—was originally from Arabia, but is now widely spread through the tropics and temperate zones of both hemispheres. The varieties are very numerous, and there are no less than fourteen hundred said to be cultivated in France alone. The fruit of the vine (the *grape*, when newly gathered, and the *raisin*, when dried) is extensively used as an article of dessert, and its juice furnishes wine by fermentation. *Verjuice*, a harsh acid juice, is obtained from the unripe grape. Currants or *Corinthian raisins* are obtained from a remarkably small variety of black grape, called the *Black Corinth*.

95. Wine is the product of the fermentation of the juice of the grape; its colour, as we know, varies from red to a very pale yellow: *red wines* are made from black grapes from which the pericarp or envelope of the fruit is not separated from the juice; *white wines* are from white grapes or from black grapes, the skins of which are not permitted to remain in the juice while fermenting. During fermentation there is a great quantity of carbonic acid disengaged, and when the wine is put into bottles

before this process is terminated, this gas remains imprisoned in the liquid, and, escaping the moment the cork is withdrawn, renders the wine sparkling and frothy: Champagne is of this kind.

96. The FAMILY OF PAPAVERACEÆ (fig. 161) also belongs to the class of Hypopetaleæ; the type of this family is the poppies, plants from which opium is obtained. The flower of the poppy has a calyx with two concave and very caducous sepals; a corolla with four large petals, which, before their expansion, are plaited or wrinkled; a great many stamens, a one-celled ovary, which becomes an oval capsule enclosing a great number of seeds. The red poppy — *Papaver rhæas* — (fig. 161)



Fig. 161.—RED POPPY.

95. What is wine? What renders some wine sparkling?

96. To what class does the family of Papavera'ceæ belong? What is o'pium? What is lau'danum?



so common in our gardens, belongs to this genus ; but the most celebrated species is the white poppy — *Papaver somni'ferum* — because the juice that is extracted from the capsules constitutes opium, a peculiar substance which has the property of calming pain and inducing sleep, when taken in small quantity, but in a large dose, is a violent poison. Dissolved in proof-spirits it constitutes lau'danum.

97. The FAMILY OF RANUNCULA'CEÆ or Crowfoot tribe (*fig. 162*) also belongs to the class of Hypopeta'leæ. It consists of *herbs* or very rarely shrubs. The petals are from three to fifteen, hypog'y'nous, in one or more rows. The leaves are alternate or opposite, generally much divided, with the petiole dilated and forming a sheath half clasping the stem. The Anemone, Buttercup, Monk's-hood, and Traveller's-joy, are of this tribe. The plants of this family are in general acrid and caustic, and some are even poisonous.



*Fig. 162. — RANUNCULUS.*

98. The FAMILY OF CRUCIFERÆ is also composed of plants with hypog'y'nous stamens ; almost all of them are herbaceous ; the leaves are alternate, and the flower has four ungui'culate petals arranged in the form of a cross, and six tetrad'y'namous stamens (four long and two short), and the fruit is a silique. In it we place mustard — *Sinapis* — Cabbages — *Bras'sica* — Radish — *Raphanus sati-vus*, &c.

99. The FAMILY OF RESEDA'CEÆ, the type of which is the *Reseda* or *Mignonette*, that of the VIOLA'CEÆ, which includes *Violets*, &c., that of the CARYOPHI'LLÆ, which includes the caper-bush (*Capparis spinosa*), &c., and several other families belong to the class of Hypopeta'leæ.

100. The FAMILY OF LEGUMINO'SÆ, of the class of Peripe-ta'leæ, is, next to the grasses, one of the most useful, on account

97. What are the characters of the family of Ranuncula'ceæ ?

98. What are the characters of the family of Cruciferæ ?

99. Name some other families of the class of Hypopeta'leæ.

100. What are the characters of the family of Legumino'sæ ?

of the abundant and various aliment it furnishes for man and the domestic animals. Some of these plants are herbaceous, and others are even very tall trees; their flowers are generally composed of a monosepalous calyx, ordinarily campanuliform or tubular, and a corolla with five unequal petals, the general form of which bears some resemblance to that of a butterfly; the stamens are almost always ten in number, and joined together in two unequal fasciculi; the fruit is a pod or legume, generally elongated, compressed, bivalve, and has a single cell enclosing seeds which are ordinarily globular or lenticular. The leaves are almost always alternate, and the stem varies much.

101. This very natural family has been divided into three sections, the *Papilionaceæ*, *Cassiæ*, and *Mimosæ*.

102. The *Papilionaceæ* are characterized by the papilionaceous corolla (fig. 94), and have, in general, ten diadelphous stamens, as broom (*Spartium scoparium*), pea (*Pisum sativum*), laburnum (*Cytisus laburnum*).

103. The *Cassiæ* have an equal and regular corolla of three or five petals, and ten stamens, of which some are frequently abortive, as the Senna shrub (*Cassia senna*), the Tamarind tree (*Tamarindus indica*).

104. The *Mimosæ* have a double calyx, the external small and of five teeth, the internal monosepalous and tubular (sometimes called corolla), and numerous stamens, generally monadelphous, as the sensitive plant—(fig. 163)—(*Mimosa pudica*)—the Gum Arabic tree (*acacia vera*), &c. The most common feature of the family of Leguminosæ, is (Mr. Lindley observes) “to have what are called papilionaceous flowers; and when these exist, no difficulty is experienced in recognising the order, for papilionaceous flowers exist nowhere else. Another and more invariable character is



Fig. 163.—SENSITIVE PLANT.

101. How is the family of Leguminosæ divided?

102. How are the *Papilionaceæ* characterized? (from the Latin, *papilio*, a butterfly, because the flower bears some resemblance to a butterfly.)

103. What are the characters of the *Cassiæ*?

104. What are the characters of the *Mimosæ*?

to have leguminous fruit; and by one of these two characters all the plants of the family are known."

105. Many plants of this family yield seeds, the coty'ledons of which are thick and fleshy, and formed chiefly of fecula, that serve us for food; others furnish gum, the different *a'caciæ* for example; some are used as purgative medicines, such as the senna and tamarind; and others yield colouring matters, which are very useful in the arts, such as indigo, campeachy wood, &c.

106. Most of our fruit trees belong to the FAMILY OF ROSA'CEÆ, the type of which is the rose tree. This family takes its place near the Lëgumino'sæ, in the division of peripetalous dico'ty'ledons. The flower of these plants is composed of a monosepalous calyx, with four or five divisions, and a corolla almost always composed of from four to five petals regularly displayed; the stamens are generally numerous; the leaves are alternate, and the form of the fruit varies a great deal. We place in this family, which also includes many ornamental plants, the apple, pear, plum, cherry, peach, apricot, quince, medlar, almond, strawberry, raspberry, dewberry, &c.

107. The *apple tree*—*Pyrus malus*—grows to from fifteen to twenty feet in height, and bears oval, dentate leaves, smooth on both sides, and white flowers tinted with rose colour externally. It is indigenous to the forests of Europe, and in the wild state, flowers about the beginning of May, but earlier when cultivated. The structure of its fruit has already been mentioned (*fig.* 116). More than a hundred varieties are known; this tree only flourishes in temperate climates, and succeeds best in a deep and slightly humid soil; it may live two hundred years. The apple is a wholesome and agreeable fruit; the most important product from it is *cider*, a more or less spirituous liquor, obtained by fermenting the juice of the fruit, which is obtained by pressing it.

108. The *pear tree*—*Pyrus communis*—a tree similar to the preceding, is also indigenous to the forests of Europe; it succeeds best in a rich soil, but also accommodates itself to dry and sandy situations. Pears are very much esteemed, and vary very much in taste as well as in form; their juice by fermentation yields a liquor very similar to cider, called *perry*.

109. The *plum*, *apricot*, *peach*, and *cherry*, differ from the preceding in the structure of their fruit, which is a fleshy, round

105. In what manner are the Mimosæ valuable to us?

106. What are the characters of the family of Rosa'ceæ? What plants are included in this family?

107. What are the characters of the apple tree? What is cider?

108. What is perry?

109. What are prunes?



drupe, slightly furrowed on one side, containing a nut enclosing one or two oleaginous seeds. The *domestic plum* — *Prunus domestica* — is a hardy tree of middle size, which accommodates itself to all kinds of soil; when left to itself it grows straight and pyramidal, but from trimming forms a rounded top; the leaves are oval, smooth above and slightly pubescent below; its flowers are white; and its fruit, the colour and form of which varies, has a smooth skin, without down, and more or less covered by a very fine powder, called *flour*. Nearly all the species of plums may be dried in the sun or in an oven and converted into *prunes*.

110. The *common cherry* — *Prunus cera'sus* — is analogous to the plum; it appears to be originally from Asia, and Pliny informs us that in the year of Rome 880, Lucullus, after his victory over Mithridates, introduced it into Italy. This tree delights in temperate climates, and yields abundance of excellent fruit.

111. The *apricot* — *Prunus armeni'aca* — appears to be originally from Armenia; every one knows the fruit of this tree, and the form of its stone or nut. The *peach* — *Amy'gdalus persica* (of which the nectarin is a variety) — and the *almond* — *Amy'gdalis communis* and *Amy'gdalus ama'ra* — belong to the same genus, but differ from the apricot in the nut, the surface of which, instead of being smooth, is irregularly and deeply furrowed. The peach is originally from Persia, and does not prosper except in localities where it is exposed to the influence of the sun; when carefully trimmed it may live forty years. The *almond* is a tree of twenty-five to thirty feet high; its trunk is rugged, and covered with an ash-coloured bark; the leaves are straight, pointed and dentate; the flower is white, and expands before the leaves are developed; the fruit is ovoid, elongated, a little fleshy, and of a green colour; and the bony case which envelopes the almond kernel is sometimes thin and pliable, and at others, thick and very hard. There are two principal varieties; one called the *bitter*, and the other the *sweet* almond; both contain a good deal of oil, and yield, when rubbed up in water, an emulsion called almond milk, which forms the basis of *orgeat*. Bitter almonds also contain, in very small quantity, a very volatile substance, called hydrocy'anic or prussic acid, which is a most violent poison.

112. The *strawberry* — *Fraga'ria vesca* — is an herbaceous

110. Where is the cherry tree from, originally?

111. What are the characters of the almond tree? What is orgeat?

112. What are the characters of the strawberry?

plant with a very short stem; almost all the leaves are radical, and ordinarily consist of three leaflets borne on a long petiole; the collum of the root gives rise to slender, long, repent shoots, which take root, from point to point, put forth leaves, and thus form new stems; from the midst of these leaves rise two or three simple, slender stems, which bear on their summit from four to six white flowers. The red, fleshy body which succeeds the flower, and known under the name of strawberry, is commonly taken for the fruit of this plant, but is nothing but a prolongation of the common support of the seeds, which becomes succulent and very much developed; the true fruit, that is, the seeds and their envelope, adhere to its surface. This plant grows throughout Europe, and in most places in North and South America.

113. *Raspberries* — *Rubus idæus* — which have nearly the same structure as the strawberry, are furnished by a shrub of the genus of bramble, which belongs to the family of Rosa'ceæ. Botanists call the raspberry the *bramble of Mount Ida*, because it grows wild on that mountain, but it is also originally from the northern regions of Europe and America; it delights in a light and somewhat shaded soil. Its root is a ligneous stock which produces several straight stems armed with numerous fine thorns; its flowers are white, quite small, and borne on slender peduncles. Its fruit is composed of many small monospermous berries slightly attached to each other, and placed round a conical, fleshy support. The dewberry — *Rubus cæsius* — yields a fruit of similar character, but it is without the taste and perfume of the raspberry.

114. The FAMILY OF CUCURBITA'CEÆ belongs to the same class as the preceding, and is composed of large herbaceous plants, the fruit of which is a pepo. The pulpy matter found in the fruit of most of the plants of this family is wholesome and often very nutritious. The melon or cantaloupe, so much prized as a dessert fruit, is obtained from the *Cu'cumis melo*; the common cucumber is the fruit of the *Cu'cumis sativus*. Besides these, we have the water-melon — *Cu'cumis citrullus* — and the squash-gourd, &c. The FAMILY OF MYRTIA'CEÆ or MYRTÆ, and several others also take their place in the division of polypetalous dicotyledons.

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113. What are raspberries?

114. What are the characters of the Cucurbita'ceæ?



Fig. 164.—CACTUS.

115. To the same division of *Peripeta'leæ* belong the Indian figs, or *Ca'ctææ*, or *Nopa'teæ* (fig. 164); they are known by the stamens being indefinite, the calyx and corolla being imperceptible, or very minute, and their succulent character. The fruits of many of the *Ca'ctææ* are pulpy and refreshing. The milky juice of some of the plants in this family is very dangerous, as that of the *Cactus grandiflorus*, *Cactus flagelliformis*, &c. The insect called *Cochineal* (*Coccus cacti*) is found on some species of cactus.

#### DICLINOUS\* DICOTY'LEDONS.

116. This fourth division of the dicoty'ledons is composed, in the method of Jussieu, of plants, the flowers of which are truly unisexual and diclinous, that is, the two sexes are not found in the same individual; but it is not very natural and is not adopted by the majority of the botanists of the present day.

In this division we place the *Euphorbia'ceæ*, the *Cupuli'feræ*, or *Amenta'ceæ*, the *Urti'ceæ*, the *Coni'feræ*, &c.

117. The FAMILY OF *URTI'CEÆ* is composed of plants, both herbaceous and ligneous, the juices of which are often milky, the flowers are apetalous, joined in a catkin or enclosed in a fleshy involucre, and have hypogy'nous stamens; the fruit is composed of a crustaceous achenium enveloped by the calyx or involucre. We place in this family the hop (*Humulus lupulus*), which is valued in brewing for the bitter quality of its strobili or cones; the banyan tree (*Ficus religiosa*); the fig (*Ficus carica*); nettle (*Urtica dioica*); the well known plant which furnishes hemp (*Cannabis sativa*); mulberry (*Morus nigra*). The bark of the *Morus papyrifera* furnishes the paper of the Chinese. The bread-fruit tree (*Artocarpus incisa*); the elm, &c.

118. The *hemp*—*Cannabis sativa*—belongs to the family of *Urti'ceæ*; it is an herbaceous, diœceous plant, the male flowers of which are arranged in axillary and terminal panicles, and the female flowers are sessile in the axils of the superior ramuscles; these flowers have a single envelope which takes the place of

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\* **DICLINOUS**: (from the Greek, *dis*, two, and *kline*, bed.) This term is applied to plants in which the sexual organs exist separately in different flowers, that is, not having both sexes in the same flower, being unisexual.

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115. How is the family of *Nopa'leæ* known? What is cochineal?

116. What kind of plants are included in the class of *Dicli'nææ*?

117. What are the characters of the family of *Urti'ceæ*?

118. What is hemp? For what is it used?



calyx and corolla; it is entire, oblong or conical, and in the female flowers laterally cleft, while in the male, it presents five oblong and slightly concave parts. We know but one species of this genus; its straight, quadrangular stem rises from five to six feet high; the leaves are digitate, acuminate, and dentate; at the base of the stem, opposite, and alternate above. In this plant, as well as almost all of the diœcia, the males are not so tall as the females, and, through a singular error, they are always regarded by the ignorant, as the female, and *vice versa*. Hemp is originally from Persia, and has been as long in use as flax; it is cultivated in great quantity in different parts of Europe, and even grows there spontaneously. It is sown in the month of June in very rich soil; the *female* plants, which ripen later than the male, are chiefly cultivated for the seed, from which an oil is obtained, for burning in France, for eating in Russia, and painting in England. Within a few years hemp has been cultivated in the United States. It is manufactured into ropes for rigging ships, &c.

119. The *elm* is also a plant of the family of Urti'ceæ. Its flowers, which are hermaphrodite, are very small and united in clusters at the upper part of the ramifications of the stem; they expand before the leaves, which are simple and alternate. This tree is indigenous in France, and acquires a great size; it is frequently employed in forming shady avenues, and its wood is useful.

120. The *bread-fruit* of the South Sea Islands bears a pulpy fruit, which, when gathered before being ripe, is roasted; it tastes like bread made of wheat flour and potatoes. The inhabitants of Tahiti and the adjacent islands feed upon it nearly throughout the year.

121. The FAMILY OF CUPULI'FERÆ or AMENTA'CEÆ, contains several of our most important forest trees, such as the oak, beech, and chestnut. It is composed of trees with simple, alternate leaves; the male flowers are arranged in cylindrical and scaly catkins, and the female flowers are generally axillary and entirely, or in part, covered by a scaly cupule; the fruit is always a gland, which is commonly unilocular, and always accompanied by a cupule. There are several species of oak known; the *common* or *red oak* is a magnificent tree which grows to a height of sixty or seventy feet; the leaves are laterally incised into obtuse lobes, and almost always regularly opposite; the male flowers

119. What are the general characters of the elm?

120. Where is bread fruit found? How is it eaten?

121. What are the characters of the family of Cupuli'feræ? (from the Latin, *cupulum*, a little cup, and *fero*, I bear.) What description of plants does this family contain? What are the characters of the oak? What is tan?

form long, slender catkins at the upper part of the young branches; and the female flowers are sessile, and grouped in the axils of the upper leaves. This tree grows slowly, but lives for a long time; it rarely begins to bear glands (acorns) at an early age, but does not cease to grow till the end of three or four centuries. Its wood is very valuable on account of its hardness and durability, and is used for frame-work in building. Its bark, which is very astringent, is also very useful, because it serves to make *tan*, a substance by means of which skins are *tanned*, and form leather.

122. Nut-galls, which are employed for making ink, and for dyeing black, are excrescences produced by the sting or puncture of a little insect on the branches of a species of oak in Asia Minor.

123. The *holm-oak* or *evergreen-oak* which abounds in the South of Europe, has dentate leaves, which remain throughout the winter. The same is true of another species of this genus, known as the cork tree, because it furnishes cork. This substance, which is spongy and elastic, is the herbaceous layer of the bark, which is removed from the tree every eight or ten years; there are a great many of these trees in Spain, and also in the South of France. The outer bark is the cork, but there is an interior bark which is left on to protect the tree, so that stripping off the outer bark is so far from injuring the trees, that it is necessary to their continuation. Trees that are never barked are said to die at the end of fifty or sixty years. The bark is removed for the first time when the tree is about fifteen years old. It is taken off in sheets, and after being detached, it is flattened by presenting the convex side to heat, or by pressure. In either case it is charred (slightly burned) on both surfaces to close the transverse pores previously to being sold. The carbonized surface produced by this charring may be seen in bungs (for casks), but not in corks, which being cut in the lengthway of the bark, the charring is taken off in the rounding.

124. The *live-oak*—*Quercus virens*—grows to the height of forty or fifty feet, spreading its branches, when in open places, extremely wide; it yields the finest and most durable ship-timber of any species known; for which reason it is considered one of the most valuable trees in the United States. It is chiefly found in Florida, and the Southern States.

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122. What are nut-galls? What are they used for?

123. What tree furnishes cork? What is the reason that we see sheets of cork slightly charred?

124. Where does live-oak grow?

125. The *chestnuts* — *Casta'nea* — form another genus of the same family as the preceding; the fruit is a species of nut with a single cell, which encloses two or three seeds containing a good deal of fecula, and is entirely enveloped by the cupule, the surface of which is studded with sharp points. The common chestnut is a large beautiful tree which grows spontaneously in the forests, nearly throughout Europe and different parts of North America; it sometimes acquires an enormous size; there is one on Mount Etna said to be one hundred and ten feet in circumference; it is hollow, and a little house has been built in its interior, with a hearth where they cook chestnuts which are often gathered from the tree itself. In Cevennes, Limousin, and some other parts of France, the peasants live almost exclusively on chestnuts. The wood is used in building; it is extremely durable, and in high esteem for posts and rails to construct fences. The chinquapin nut—*Casta'nea pu'mila*—is a small tree, or rather a shrub, growing to the height of thirty feet in the Southern States, but scarcely exceeding seven or eight in cold latitudes. The fruit is very sweet and agreeable to eat.

126. The *yoke-elm* also belongs to the family of Cupuli'feræ; the male and female flowers are arranged in catkins, composed of imbricated scales. It is a tree easily shaped by trimming, and for this reason is often employed in Europe for hedges; it sometimes rises to fifty or sixty feet in height, and its wood, which is very hard, is much used by wheelwrights, and for fuel.

127. A great many European forests are formed of trees of the FAMILY OF CONI'FERÆ, which is placed in the class of Dicl'i'næ, alongside of the Cupuli'feræ; they are generally designated under the title of *evergreens* and *resinous* trees, because they preserve their leaves through the winter, and because their wood contains a great quantity of resin (commonly called rosin). Almost all of them have stiff, linear, coriaceous leaves; their flowers are unisexual, and arranged in cones or catkins which are ordinarily scaly; and generally the fruit also is a scaly cone. Fir trees and pines are types of this family; these two genera are distinguished from each other by their aspect, by their leaves, which are solitary on the fir tree, and united in fasciculi or bunches of from two to five on the pines; by the male flowers, the catkins of which are isolated and solitary on the pines, and united and grouped on the fir tree, and by several other characteristics. Both delight in mountainous regions, and on sandy

125. What are the characters of the chestnut tree? What plant furnishes chinquapins?

126. What are the characters of the yoke-elm?

127. What are the characters of the family of Coni'feræ? (from the Latin, *conus*, a cone, and *fero*, I bear.) Where do pines most abound?



plains. Pines abound especially in the north, where they form forests of vast extent; the stem is straight, and their height frequently colossal; a great many species are known.

128. The Jersey pine, pitch, or scrub pine, is of middle size, straggling growth, and full of resin. Its branches are tougher than those of any other pine, and might be used for many purposes if its wood were not subject to so early a decay. The pitch pine is generally known in its native country by the name of Norway pine; sometimes, particularly among the Canadian French, red pine. It grows in close forests, is very tall, and its bark remarkably smooth and red; the timber is very heavy; for which reason it is rejected for masts, though its shape and size appear to recommend it for that purpose. The yellow pine is most in use for building houses as well as shipping. The loblolly or old field pine is found in large tracts in the Southern States; all the woods seem to be filled with its seeds; for when any piece of clear land is neglected for any space of time, it will be covered by these pines. It is difficult, and in some cases almost impracticable, to recover lands so run over, as the ground appears to have lost all fertile properties for other vegetation. The long-leaved, yellow, pitch, or brown pine, is a beautiful, as well as a very useful tree. The white or Weymouth pine grows in the State of Vermont, to an enormous size; it is the best timber in America for masts.

Turpentine, resin, tar, and pitch, are the products of several species of pines, and are exported in large quantities from the United States.

The common fir is found in the same countries as the wild pine. Larch and cedar are very analogous to the fir tree.

#### OF THE USES OF PLANTS.

From the short sketch we have just given of the vegetable kingdom, we see how many important and varied services are rendered to us by plants. Either directly or indirectly, all animals are nourished by plants; indeed, there is an immense number of animated beings that eat nothing but vegetable substances, and those that feed upon meat would not find sufficient food, unless they devoured each other, without destroying those that are maintained on vegetable food exclusively. There is scarcely a plant that does not nourish some animal; almost all insects, for example, live either in the perfect or in the larva state, at the expense of the plant upon which they are habitually found; and even in the highest classes of the animal kingdom, the number of

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128. What species of pine are most prevalent in the United States? What is tar procured from? What plants yield turpentine?

phyti'vorous\* species is immense, for the quadruma'na,† the gnawers, the pa'chyderms,‡ and the ruminants, all observe a vegetable diet; and man himself derives most of his food from the vegetable kingdom.

Among the most important alimentary plants, the first are the *cereals*. Under this name we designate plants of the *family of grasses*, which afford nourishment to man and most domestic animals; namely, wheat, rye, barley, oats, maize, and rice. There is in the interior of their seed, betwixt the spermoderm and the embryo, a considerable deposit of amylaceous§ matter, designed to nourish the young plant, and designated by botanists under the name of *albumen* or *perisperm*; it is this matter we use for food. We have already studied the history of these plants, consequently it is useless to repeat it. We will, however, add here, that the perisperm of the cereals, and consequently the flour obtained by grinding them, is essentially composed of *fecula* or starch, ordinarily mixed with a certain quantity of a substance named *gluten*, which considerably resembles animal matter. Wheat flour contains more gluten than any other, and for this reason, it makes better bread and is more nutritious; rye also contains it, but there is none in rice, oats, &c.

Other plants also furnish abundance of *fecula*, but not from the same part as in those mentioned; sometimes it is in the coty'ledons of the seed, sometimes in tubercles, and at other times in the very substance of the stems or roots; thus, peas and beans and some other plants of the family of Legumino'sæ, furnish edible seeds, the coty'ledons of which contain the same as the albumen of the cereals, a great deal of *fecula*, and a certain quantity of gluten mixed with sugar and some other matters. Whatever part this *fecula* may occupy, it in general constitutes, as in the pericarp of the cereals, depositories of nutritive matter for the nourishment of the young plant, or of new shoots.

The tubers of the potatoe owe their nutritious qualities to the quantity of *fecula* they contain; the same is true of *batatas*|| (the Spanish or sweet potatoe), a species of convolvulus, originally

\* Phyti'vorous. — From the Greek, *phuton*, plant, and *voro*, I eat; plant-eating.

† Quadruma'na. — From the Latin, *quadrinus*, formed from *quatuor*, four, and *manus*, hand; having four hands.

‡ Pa'chyderm. — From the Greek, *pachus*, thick, and *derma*, skin.

§ Amyla'ceous. — From the Latin, *amy'lum*, starch; starchy.

|| *Batatas* is either a Malay or Mexican word. The plant is a native of both the East and West Indies, and China. It was first carried to Spain from the West Indies, and annually imported into England, and sold as a delicacy. It is the potatoe of Shakspeare and his cotemporaries, the common or Irish potatoe being then scarcely known in Europe.

from India, which is now cultivated in all warm regions in the world. The species of fecula, known under the name of *cassava* or *tapioca*, of which great use is made in the West Indies, is derived from the root of the manioc, a plant of the family of Euphorbia'ceæ, which also contains a very poisonous juice that is separated by means of water. *Sago* is another species of fecula obtained from the stem of a palm, and *salep* is also a fecula obtained from the stem of a monocotyle'donous plant of the family of Orchi'deæ.

The most esteemed of our fruits, the majority of them at least, are furnished by the family of Rosa'ceæ: for example, apples, pears, plums, cherries, peaches, apricots, strawberries, raspberries; and to complete the list of fruit trees we must not omit the mention of some species of the family of Ampeli'deæ, and the family of Aurantia'ceæ; namely, the vine, the orange, and citron.

Plants furnish us not only with wholesome and agreeable food, but also substances which are of the greatest utility in the manufacture of clothing, and in the construction of our dwellings. Hemp, flax, and cotton, yield us long, flexible filaments, which constitute excellent materials for spinning and weaving; and our forest trees, almost all of which belong to the family of Cupuli'feræ, or that of the Coni'feræ, furnish abundance of wood for building our houses and ships, as well as for the manufacture of furniture, and instruments of various kinds.

Ornamental plants which decorate our gardens and conservatories are very numerous; they are furnished by very various families, in the front rank of which we may place the rosa'ceæ, because it has for its type one of our most beautiful flowers, the *rose*. Many species and varieties of rose trees are known, and almost all of them may be cultivated in the open air, in our climate; they flourish best in a light soil and partial exposure to the sun. In the wild state, they have but five petals, in the midst of which we observe a great number of stamens; but cultivation has transformed most of these latter organs into petals, and enhanced the beauty of the flowers.

The *dahlia*, which was for some years so rare, but now everywhere met in gardens, belongs to the family of Synanthe'reæ; this beautiful herbaceous plant has a perennial root composed of bundles of horizontal, oblong tubercles, from which rises a cylindrical, branching stem, bearing opposite leaves and large flowers, which appear from the end of July till the approach of frost. The *dahlia* may be multiplied by its seeds, or by the division of its roots.

The genus *aster*, which comprises a great number of beautiful autumnal flowers, including the *Queen Margaret*, which was im-



ported from China into Europe, about a hundred years ago, also belongs to the family of *Synanthé'reæ*.

The family of *Caryophyllææ* presents our gardens with different species of carnations or pinks, known under the name of common pink, china pink, &c. The family of *Legumino'sæ* gives us *aca'cia*, the sweet pea, &c.

We have seen that a great many plants afford to man wholesome and abundant food; that others are violent poisons to him, but very many even of the latter are useful, because when prudently administered they constitute powerful medicines.

A great number of plants of the family of *Sola'nææ* are of this kind; for example, belladonna, henbane, stramonium, tobacco; some species of the family of *Papavera'ceæ*, such as the poppies; and hemlock, which belongs to the *Umbelli'feræ*, &c. &c. In our citation of poisonous plants, we must not omit the mushrooms, the history of which we have already given.

# GLOSSARY.

## BOTANY.

- ABO'RT.**—To bring forth before the time; to fail in complete production. A seed that fails to germinate may be said to abo'rt.
- ABO'RTION.**—The act of bringing forth untimely.
- ABO'RTIVE.**—That which fails to produce or bring forth anything; falling off without producing any fruit.
- ABSO'RPTION.**—The act of swallowing up (*pages 17 and 27*).
- ACA'CIA.**—From the Greek *akantha*, a thorn. Systematic name of a genus of plants.
- ACA'ULOUS.**—From the Greek, *a*, without, and *kaulos*, stem. Without a stem.
- A'CCESSORY.**—Joined to another thing so as to increase it; additional.
- ACERO'SE.**—From the Latin, *acer*, a needle. In form of a needle.
- ACHE'NIUM.**—From the Greek, *a*, without, and *chainô*, I gape. A form of fruit.
- A'CID.**—Sour, sharp. In chemistry this term is applied to all substances which saturate and neutralize alkalies and other salifiable bases.
- ACOTY'LEDON.**—From the Greek, *a*, without, and *kotyledôn*, a seed-lobe. A class of plants.
- A'COTYLE'DONOUS.**—Belonging or relating to acoty'ledons.
- ACU'MINATE.**—From the Latin, *acumen*, a point. Pointed.
- ACU'TE.**—More gradually sharp pointed than acuminate. In botanical language every angle is acute.
- ADVENTITIOUS.**—Accidental. *Adventitious roots* are those which grow from the stem (*page 19*). *Adventitious buds* are those which grow on parts of the stem where they are not commonly met.
- ÆQUA'LIS.**—Latin. Equal; even.
- ÆSTIVA'TION.**—From the Latin, *æstivus*, of or belonging to summer. A figurative expression employed to indicate the manner in which the parts of a flower are arranged before they unfold. Botanists speak of the æstivation of the calyx, of the corolla, of the stamens.
- A'GAMOUS.**—From the Greek, *a*, without, and *gamos*, marriage. A class of plants.
- AGA'RICUS.**—Latin. Agaric.
- AGGLU'TINATED.**—From the Latin, *ad*, together, and *gluten*, glue. Joined to, or united together.
- AG'GREGATED.**—Collected together; accumulated. When a fruit is composed of several agglutinated carpels, it is said to be *aggregate*.
- AKE'NE.**—See *Achenium*.
- ALBU'MEN.**—From the Latin, *albus*, white. An immediate principle of animals and vegetables; it constitutes the chief part of the white of eggs.
- ALBUR'NUM.**—Sap-wood.
- AL'GÆ.**—Latin, plural of *alga*, seaweed. Systematic name of a family of plants.
- ALIME'NTARY.**—Affording nourishment.
- ALOPECU'RUS.**—From the Greek, *alope*, fox, and *oura*, tail. Name of a kind of grass.
- ALTE'RNATE.**—Being by turns; one after another.
- AMA'RA.**—Latin. Bitter.
- AMARYL'LIDÆ.**—Also, *Amaryllida'ceæ*. Systematic name of an order of plants, formed from *Amaryllis*, the name of one genus of the order.
- AME'NTUM.**—Latin. A cat-kin.
- AME'NTA.**—Latin. Plural of *Amentum*.
- AMENTA'CEÆ.**—Systematic name of a family of plants, in which the flowers are arranged in amenta or catkins.

AMERICA'NA. { Latin. American.  
AMERICA'NUS. }

AMPELIDEÆ.—From the Greek, *Ampe-  
los*, a vine. A systematic name  
of a family of vines.

AMPLEXICAULE.—From the Latin, *am-  
plecto*, I embrace, and *caulis*, stem.  
Stem-embracing. Applied to a  
form of leaf.

AMPU'LLA.—Latin. A bottle. Any-  
thing blown or puffed up. The  
name of a form of leaf.

AMYG'DALUS.—Latin. From the Greek  
*amugdalon*, an almond. Generic  
name of the almond tree.

AMYLACEOUS.—From the Latin, *amy-  
lum*, starch. Starchy; of the na-  
ture of starch.

ANA'LOGOUS.—Similar; bearing a re-  
semblance to.

ANDROPHORE.—From the Greek, *an-  
dros*, the genitive of *aner*, man—  
*anther*, and *phoreo*, I bear. Anther-  
bearer. A kind of sheath to the  
pistil.

ANDROPHORUM.—Latin. Androphore.

ANGIOSPERMIA.—From the Greek, *ag-  
geion*, a vessel, and *sperma*, seed.  
Name of a Linnæan order of  
plants.

ANGULINERVE.—From the Latin, *an-  
gulus*, a corner, an angle, and *ner-  
vus*, a nerve or sinew. Having  
straight nerves which form angles  
with each other.

A'NNUAL.—From the Latin, *annus*, a  
year. Yearly. A plant which rises  
from the seed, reaches perfection  
and perishes within a year.

A'NNULAR.—From the Latin, *annulus*,  
a ring. In form of a ring.

ANO'MALOUS.—From the Greek, *anô-  
malos*, unequal, irregular.

A'NTHÉR.—From the Greek, *anthera*,  
a flowery herb.

A'NTHRACITE. From the Greek, *an-  
thrax*, charcoal. Mineral charcoal.  
A kind of stone coal, which is hard  
and difficult to inflame.

APETA'LEÆ.—From the Greek, *a*, with-  
out, and *petalon*, petal. Systematic  
name of a group of plants.

APETALOUS.—Applied to flowers that  
have a calyx and no corolla, or  
neither.

A'PEX.—The top, summit, or end.

When applied to a leaf, it is the  
point most remote from the base.

APOCARPOUS.—From the Greek, *apo*,  
from, and *karpós*, fruit. Applied  
to fruits formed of a single carpel.

APOTHE'CUM.—From the Greek, *apo-  
theke*, a repository.

APPARA'TUS.—An assemblage of or-  
gans.

ARBORE'SCENT.—From the Latin, *ar-  
bor*, a tree. Stems of plants which  
are at first herbaceous and after-  
wards become somewhat woody  
and tree-like.

A'RIL.—A coat or covering of certain  
seeds, formed by the expansion of  
the funicula or placenta.

ARI'LLUS.—Latin. Aril.

ARI'STATE.—Awned.

ARISTOLOCHIA.—From the Greek, *ari-  
sos*, excellent, and *lochos*, female,  
because it was supposed to be ex-  
cellent for females in particular  
conditions. Name of a family of  
plants.

ARMEN'ACA.—Latin. Armenian.

AROMA'TIC.—From the Greek, *aroma*,  
an odour. Spicy; fragrant.

ARTICULATE.—Jointed. Articulate  
leaves are those attached to the  
stem by a sort of joint.

ARTICULA'TION.—A joint.

ARTOCAR'PUS.—From the Greek, *artos*,  
bread, and *karpós*, fruit. Generic  
name of the bread-fruit tree.

ASCI'DIUM.—From the Greek, *askos*, a  
bottle or pitcher. A kind of leaf.

ASPARAGINEÆ.—From the Greek, *spa-  
rassô*, I tear, or *asparagos*, a term  
applied to the tender shoots of  
plants. Systematic name of a fa-  
mily of plants.

ASPHODE'LEÆ.—From the Greek, *as-  
phodelós*, name of a flower. Sys-  
tematic name of a family of plants.

ASSIMILA'TION.—The act by which liv-  
ing bodies (plants or animals) ap-  
propriate and transform into their  
own substance, matters with which  
they may be placed in contact. As-  
similation is therefore a part of the  
function of nutrition.

ASSO'LEMENT.—French. The art of  
arranging crops in proper succe-  
sion, according to the soil, to secure  
the greatest production.



- A'STER.**—From the Greek, *aster*, a star. Name of a genus of plants.
- AT'ROPA.**—From the Greek, *atropos*, "the Goddess of Destiny;" so called from its fatal effects. Name of a genus of plants.
- AURANTIA'CEÆ.**—From the Latin, *aurantium*, an orange. Name of an order of plants.
- AURA'NTIUM.**—Latin. An orange.
- AURI'ULATE.**—From the Latin, *auricula*, a little ear. A form of leaf which has ear-like lobes or projections at the base.
- AUTOMA'TIC.**—From the Greek, *autos*, self, *maten*, easily, or *automatos*, spontaneously. That which acts of itself.
- A'VENA.**—Latin. Oats.
- AWNED.**—Terminating in a long hard bristle.
- A'XIL.**—From the Latin, *axilla*, armpit. The angle or point at which a leaf or branch unites with the stem.
- A'XILLARY.**—Belonging to an axil or axilla.
- A'ZOTE.**—From the Greek, *a*, privative, and *zoe*, life. A name given to nitrogen because it will not support animal life.
- BAMBU'SA.**—Bamboo.
- BATA'TAS.**—Sweet potatoes.
- BICRENATE.**—From the Latin, *bis*, two, and *crena*, a notch, a slit. Doubly crenate.
- BIE'NNIAL.**—From the Latin, *bis*, two, and *annus*, year. A term applied to plants which grow one year and flower the next, after which they perish; they only differ from annuals in requiring a longer time to produce fruit.
- BI'FURCATION.**—From the Latin, *bis*, two, and *furca*, fork. The point where a part forms two branches like a fork.
- BIJU'GATE.**—From the Latin, *bis*, two, and *jugum*, yoke. A leaf formed of two pairs of leaflets.
- BILO'BATE.**—Having two lobes.
- BILO'CLAR.**—From the Latin, *bis*, two, and *loculus*, partition. Having two cells.
- BI'NATE.**—From the Latin, *bis*, two, and *natus*, grown. A form of leaf composed of two leaflets.
- BIPIN'NATE.**—Doubly pinnate.
- BITE'RNATE.**—Doubly ternate.
- BITU'MINOUS.**—Relating to bitu'men; mineral pitch.
- BIVA'LVE.**—From the Latin, *bis*, two, and *valva*, door. Composed of two parts, joined together like doors.
- BORAGI'NEÆ, or Boragina'ceæ.** Name of a family of plants of which the *Borago* is the type.
- BO'TANY.**—From the Greek, *botane*, a plant. Natural history of plants.
- BRA'SSICA.**—Latin. Cabbage.
- BRAC'T.**—From the Latin, *bractea*, a thin leaf of metal. A floral leaf different in colour from other leaves.
- BRA'CTEÆ.**—Latin. Bracts.
- BULB.**—A collection of fleshy scales arranged like those of a bud, of which the bulb is a slight modification, separating spontaneously from the stem to which it belongs, and emitting roots from its base.
- BU'LBIOUS.**—Belonging or relating to a bulb.
- CADU'COUS.**—From the Latin, *cado*, I fall. Applied to leaves which fall off early.
- CÆ'SIUS.**—Latin. Grey.
- CA'LAMUS.**—A genus of palms.
- CA'LICES.**—Latin. Plural of calyx.
- CA'LYX.**—The cup of a flower.
- CALY'PTRA.**—From the Greek, *kaluptra*, a covering. Part of the capsule of a moss.
- CA'MBIUM.**—A low Latin word for liquid which becomes glutinous.
- CAMEL'LIA.**—A genus of the family of *Aurantia'ceæ*, named in honour of Kamel, a botanist.
- CAMPA'NULATE.**—Bell-shaped.
- CAMPANU'LIFORM.**—From the Latin *campanula*, a little bell, and *forma*, shape. In shape of a bell.
- CANI'CLATED.**—Channelled or furrowed.
- CANNA'BIS.**—Latin. Hemp.
- CAPIL'LARY.**—From the Latin, *capillus*, a hair. Hair-like.
- CA'PITAL.**—From the Latin, *caput*, head. An assemblage of flowers on a common receptacle.
- CAPITA'TI, flores.**—Flowers collected into heads, as thistles and other plants, with compound flowers growing with a head.

- CAPITA'TUS**.—Headed.
- CAPITULUM**.—Latin. A capital.
- CAPPARIS**.—Latin. Caper-bush.
- CAPRIFOLIA'CEÆ**.—Systematic name of a family of plants, formed from the genus *Caprifolium*, which is derived from the Latin, *capra*, goat, and *folium*, leaf.
- CAPSULE**.—From the Latin, *capsula*, a little casket or chest. A form of fruit.
- CARBON**.—See page 53.
- CARICA**.—Latin. A kind of dry fig.
- CARINA**.—Latin. A keel.
- CARPEL**.—From the Greek, *karpos*, fruit. Certain appendages or parts of the pistil are called carpels.
- CARYOPHYLL'LEÆ**.—From the Latin, *caryo'phyllus*, the garden pink. Systematic name of a family of plants.
- CARYOPHYLLA'CEOUS**.—Belonging or relating to the caryophyllææ.
- CARYO'PSIS**.—From the Greek, *karuon*, a nut, and *opsis*, resemblance. Name of a form of fruit, as the grain of wheat, for example.
- CASTA'NEA**.—Latin. Chestnut.
- CATKIN**.—A form of inflorescence.
- CAUD'EX**.—Latin. A trunk of a tree.
- CAULIS**.—Latin. Stem.
- CAUSTIC**.—From the Greek, *kaiô*, I burn. Substances which possess the property of destroying organic structure are so termed.
- CELLULAR**.—Composed of cells.
- CENOMY'CE**.—From the Greek, *kenos*, empty, and *mukes*, a diminutive fungus. A kind of lichen.
- CERASUS**.—Latin. A cherry tree.
- CEREAL**.—From the Latin, *ceres*, corn. Applied to grasses which produce the bread corns; as wheat, rye, barley, oats, maize, rice and millet.
- CHENOPO'DEÆ**.—From the Greek, *chen*, goose, and *pous*, foot. Name of a family of apetalous dicotyledons.
- CHICORA'CEÆ**.—From the Greek, *ki-chôre*, garden succory. Systematic name of a family of plants.
- CHOND'RUS**—(pronounced *kond'rus*). From the Greek, *Chondros*, cartilage. Name of a genus of seaweeds.
- CICA'TRICES**.—Plural of cicatrix.
- CICA'TRIX**.—Latin. A scar.
- CILIA'TUS**.—Latin (from *cilium*, eyelash). Having the margin guarded by parallel bristles, like the eyelash.
- CINCHO'NA**—(pronounced *sinkônah*). Name of Peruvian bark, so called from the Spanish Viceroy's lady, the Countess of Cinchon, who was cured of fever by it, at Lima, about 1638.
- CIRR'OSO-PINNATE**.—From the Latin, *cir'rus*, a tendril, and *pinna*, wing. A form of pinnate leaf having tendrils at the extremity.
- CITRUS**.—Latin. Lemon or orange tree.
- CITRULLUS**.—Latin. Diminutive of citrus.
- CLAW**.—The inferior part of a petal, corresponding to the petiole of a leaf.
- CLO'STES**.—Elongated, spindle-shaped cells.
- CLUSTER**.—When flowers are borne on a common, irregularly branched peduncle, they form a cluster.
- COLLUM**.—Latin. Neck. The part between the stem and root.
- COMMUNIS**.—Latin. Common.
- COMPOSITE**.—Compound.
- CONCE'NTRIC**.—Having a common centre.
- CONCE'PTICLE**.—Envelope of a sporule.
- CONIFERÆ**.—From the Latin, *conus*, a cone, and *fero*, I bear. Cone-bearing.
- CONI'UM**.—From the Greek, *kôneion*, hemlock.
- CONJUGATE**.—From the Latin, *con*, together, and *jugum*, a yoke. Yoked or joined together.
- CON'NATE**.—From the Latin, *con*, together, and *natus*, grown. Joined together at the base.
- CONNECTIVE**.—From the Latin, *connecto*, I join together.
- CONVOLVULUS**.—Latin. Bind-weed. (From *convolo*, I bind together or entwine.)
- CONVOLVULA'CEÆ**.—Systematic name of a family of plants.
- COR'DATE**.—Heart-shaped.
- COR'DIFORM**.—From the Latin, *cor*, the heart, and *forma*, shape. Heart-shaped.

- CORIA'CEOUS.**—From the Latin, *corium*, hide of a beast. Leathery.
- CORISANTH'EÆ.**—From the Greek, *koris*, St. John's wort, and *anthos*, flower. Systematic name of a class of plants.
- CO'R'MUS.**—From the Greek, *kormos*, stem. The representative of the stem in bulbous plants.
- CORO'LLA.**—Latin. A little crown.
- CORO'LLÆ.**—Plural of Corolla.
- CORPU'SCULE.**—From the Latin, *corpus*, body. A diminutive body.
- COR'RUGATED.**—From the Latin, *con*, together, and *ruga*, a wrinkle. Wrinkled.
- CO'R'TICAL.**—From the Latin *cortex*, bark. Belonging to or partaking of the nature of bark.
- CO'R'YMB.**—From the Greek *korumbos*, a helmet, a summit.
- COTY'LEDON.**—From the Greek, *kotyledôn*, seed-lobe.
- COTYLE'DONOUS.**—Belonging or relating to a cotyledon.
- CRE'NATE.**—Having rounded teeth.
- CRE'NULATE.**—Finely crenate.
- CRENULA'TION.**—A rounded tooth.
- CRI'NES.**—Latin. Hairs.
- CRI'NITUS.**—Latin. Hairy.
- CRUCI'FERÆ.**—From the Latin, *crux*, a cross, and *fero*, I bear. The flowers being in form of a Maltese cross. Systematic name of an order of plants.
- CRU'CIFORM.**—Cross-shaped.
- CRYPTOGA'MIA.**—From the Greek, *kruptos*, concealed, and *gamos*, marriage. Name of a class of plants.
- CRYPTO'GAMOUS.**—Belonging or relating to Cryptogamia.
- CUCU'MIS.**—Latin. A cucumber.
- CUCURBITA'CEÆ.**—From the Latin, *cucurbita*, a gourd. Name of a family of plants.
- CULM.**—From the Latin, *culmus*, a stem. The stems of the grasses.
- CU'NIATE.** } From the Latin, *cuneus*,  
**CU'NIFORM.** } a wedge. Wedge-shaped.
- CU'PULE.**—A little cup.
- CUPULI'FERÆ.**—From the Latin, *cupulum*, a little cup, and *fero*, I bear.
- CURVINERVE.**—See page 32.
- CU'SPIDATE.**—From the Latin, *cuspis*, a point. A form of leaf terminating in a point.
- CU'TICLE.**—From the Latin, *cutis*, skin. The scarf-skin. The external covering of plants.
- CYA'THIFORM.**—From the Latin, *cyathus*, a drinking-cup, and *forma*, shape. A form of corolla.
- DECAGY'NIA.**—From the Greek, *deca*, ten, and *gune*, pistil. Name of an order of plants.
- DECA'NDRIA.**—From the Greek, *deca*, ten, and *aner*, stamen. Name of a class of plants.
- DE'CIDUOUS.**—From the Latin, *decido*, to fall off. Applied to plants whose leaves fall in the autumn, to distinguish them from evergreens.
- DECOMPO'SE.**—When the chemical constitution of substances is altered, they are said to be decomposed.
- DEHI'SCENT.**—From the Latin, *dehiscere*, to gape wide open. Applied to certain fruits.
- DELTOID.**—From the Greek  $\Delta$ , *delta*, and *eidos*, resemblance. A form of leaf (page 45).
- DE'NTATE.**—From the Latin, *dens*, tooth. Toothed.
- DIAD'ELPHIA.**—From the Greek, *dis*, two, and *delphos*, brotherhood. Name of a Linnæan class.
- DIA'NDRIA.**—From the Greek, *dis*, two, and *aner*, stamen. Name of a class of plants.
- DIA'NDROUS.**—Having two stamens.
- DICLI'NIÆ.**—From the Greek, *dis*, two, and *klinos*, bed. Name of a division of plants.
- DICLI'NOUS.**—From the Gr. *dis*, two, and *kline*, bed. Having the stamens in one flower and the pistils in another.
- DICOTY'LEDON.**—From the Greek, *dis*, two, and *kotyledôn*, seed-lobe.
- DICOTYLE'DONOUS.**—Relating to dicotyledons.
- DIDYNA'MIA.**—From the Greek, *dis*, two, and *dunamis*, power. Name of a Linnæan class, having two long and two shorter stamens.
- DIDY'NAMOUS.**—Relating to didynamia.
- DIG'ITATE.**—From the Latin, *digitus*, finger. Spread out like fingers.
- DIGY'NIA.**—From the Greek, *dis*, two, and *gune*, pistil. Name of an order of plants.



- DICE'CIA.**—From the Greek, *dis*, two, and *oikia*, house. Name of a Linnean class.
- DICE'CIOUS.**—Relating to *dicēcia*.
- DIPE'TALOUS.**—From the Greek, *dis*, two, and *petalon*, a petal. Having two petals.
- DODECAGY'NIA.**—From the Greek, *do-deca*, twelve, and *gune*, pistil. Name of an order of plants.
- DODECA'NDRIA.**—From the Greek, *do-deca*, twelve, and *aner*, stamen. Name of a class of plants.
- DOME'STICA.**—Latin. Domestic.
- DOR'SAL.**—From the Latin, *dorsum*, the back.
- DULCAMA'RA.**—From the Latin, *dulcis*, sweet, and *amara*, bitter. Bitter-sweet. Systematic name of a genus of plants.
- DURA'MEN.**—Latin. A hardening. Systematic name of heart-wood.
- E'DULIS.**—Latin. Eatable. Edible.
- ELABORA'TION.**—See *question*, page 55.
- EM'BRYO.**—From the Greek, *embruon*, from *bruô*, I bud forth.
- EMA'RGINATE.**—From the Latin, *e*, from, and *margo*, margin or edge. Notched.
- ENTI'RE.**—Even or whole on the edge.
- EN'DOGENS.**—See *note*, page 22.
- ENDO'GENOUS.**—See *page* 22.
- EN'DOCARP.**—From the Greek, *endon*, within, and *karpōs*, fruit. An internal membrane of fruits.
- EN'DOSPERM.**—From the Greek, *endon*, within, and *sperma*, seed.
- ENDOSPERMA'TIC.**—Belonging or relating to endosperm.
- ENNEAGY'NIA.**—From the Greek, *ennea*, nine, and *gune*, pistil. Name of an order of plants.
- ENNEA'NDRIA.**—From the Greek, *ennea*, nine, and *aner*, stamen. Name of a class of plants.
- E'PICARP.**—From the Greek, *epi*, upon, and *karpōs*, fruit.
- EPICORO'LLÆ.**—From the Greek, *epi*, upon, and *corolla*. Name of a class of plants.
- EPI'DERMIS.**—From the Greek, *epi*, upon, and *derma*, skin. The cuticle.
- EPIGY'NEÆ.**—From the Greek, *epi*, upon, and *gune*, pistil. Name of a class of plants.
- EPIGY'NOUS.**—Belonging or relating to Epigynæa.
- EPIPE'TALOUS.**—From the Greek, *epi*, upon, and *petalon*, petal.
- E'PISPERM.**—From the Greek, *epi*, upon, and *sperma*, seed.
- EPISPERMA'TIC.**—Relating to episperm.
- ESSE'NTIAL OILS, or VO'LATILE OILS.**—Under this term are included all those peculiar compounds obtained by distilling vegetable substances with water; and which pass over along with the steam, and are afterwards condensed in the liquid or solid form. They appear to constitute the *odorous* principle of vegetables.
- EUROPE'A.**—Latin. European.
- EUPHORBIA'CEÆ.**—From *eupho'rbiūm*, which was named in honour of Euphorbus, physician to king Juba. Name of a family of plants.
- EXCRE'TORY.**—See *page* 57.
- EXCRE'TION.**—See *note*, page 57.
- EXHALA'TION.**—From the Latin, *ex-hal'are*, to throw out. See *page* 51.
- EX'OGENS.**—See *note*, page 22.
- EXO'GENOUS.**—See *page* 22.
- EXTRA-EM'BRYO.**—When the embryo is simply applied to the surface of the albumen or envelopes, it is said to be *extra* (outside) from its position.
- FARINA'CEOUS.**—From the Latin, *farina*, meal, flour. Partaking of the nature of flour.
- FASCI'ULUS.**—Latin. A bundle.
- FASCI'ULLI.**—Plural of fasciculus.
- FASCI'ULATE.**—Collected in bundles.
- FE'CULA.**—From the Latin, *ſæx*, a sediment. When certain vegetable substances are bruised and mixed with water, the pulverulent matter which subsides is called the *fecula*; it is commonly of a starchy nature, hence starch is often called *fecula*.
- FI'CUS.**—Latin. A fig.
- FI'LAMENT.**—From the Latin *filamentum*, a shred. A little thread, like part of a stamen.
- FILAME'NTOUS.**—Of the nature of a filament.
- FI'LIFORM.**—Thread-like.
- FI'LICES.**—Latin. Ferns.
- FLOWER.**—That part in which the germ of a new plant is produced

- FLO'RAL.**—Relating to flowers. Flo-  
ral leaf is that one from the axil  
of which the peduncle or pedicel  
of a flower rises.
- FOLIA'CEOUS.**—Leafy.
- FO'LIUM.**—Latin. A leaf.
- FOLLI'CUA.**—From the Latin, *follis*,  
a bag. A little bag.
- FRONS or FROND.**—The leaves of  
crypto'gamous plants.
- FRUCTIFICA'TION.**—The flower and  
fruit with their parts.
- FRUIT.**—An assemblage of the germs  
and protecting parts destined to  
become a new plant or perfect  
seed.
- FU'NCTION.**—From the Latin, *fungor*,  
I act or discharge an office. The  
action of an organ or system of  
organs.
- FU'CI.**—Latin. Plural of *fucus*, a  
sea-weed.
- FUN'GI.**—Latin. Plural of *fungus*, a  
mushroom.
- FUNI'CUA.**—From the Latin, *funis*, a  
cord. A little cord.
- FU'SIFORM.**—From the Latin, *fusus*,  
a spindle, and *forma*, shape. Spin-  
dle-shaped.
- GAL'VANISM.**—From Professor Gal-  
vani, the discoverer. The name  
given as a general term to the  
electrical phenomena produced by  
the contact of different metals.
- GAMOP'E'TALOUS.**—From the Greek,  
*gamos*, union, and *petalon*, petal.  
A corolla composed of a single  
piece is so called.
- GAMOSE'PALOUS.**—From the Greek,  
*gamos*, marriage, and *sepal*. Hav-  
ing the sepals united together,  
forming a single piece or sepal.
- GAS.**—From the German, *geist*, spirit.  
The name given to all permanently  
elastic fluids, or airs differing  
from atmospheric air.
- GE'MINI.**—Latin. Twins.
- GE'MINATE.**—Growing in pairs.
- GE'MMINAL.**—From the Latin, *gem-  
ma*, a bud. Relating to buds.
- GE'MMULE.**—A little bud.
- GERMINA'TION.**—The process of the  
development of the seed and the  
embryo which it contains.
- GERMINA'TIVE.**—Relating to germina-  
tion.
- GLAND.**—An organ for the purpose  
of secreting a peculiar fluid, &c.
- GLA'NDULAR.**—Relating to glands.
- GLO'CHIS.**—From the Greek, *glôchis*,  
a point. A barb.
- GLOCHIDA'TUS.**—Armed with points  
or barbs.
- GLUME.**—A husk.
- GLU'TEN.**—Latin. The viscid elastic  
substance which remains when  
wheat flour is wrapped in a coarse  
cloth, and washed under a stream  
of water, so as to carry off the  
starch and soluble matters.
- GLU'TINOUS.**—Viscid, sticky, adhesive.
- GOSSE'PIUM.**—Latin. Cotton.
- GOU'RMAND.**—French. A glutton.  
One particular in his food.
- GRAFT.**—See p. 60.
- GRAMI'NEÆ.**—From the Latin, *gra-  
men*, grass. Systematic name of  
the family of grasses.
- GRA'NULE.**—A diminutive grain.
- GUM.**—A vegetable product which is  
tasteless and inodorous, and is dis-  
tinguished by being soluble in  
water and insoluble in alcohol.
- GY'NOPHORE.**—From the Greek, *gune*,  
pistil, and *phorêd*, I support. A  
support of the pistil.
- GYMNOSPE'RMIA.**—From the Greek,  
*gumnos*, naked, and *sperma*, seed.  
Name of a Linnæan order.
- GYNA'NDRIA.**—See page 102.
- HA'MI.**—Latin. Plural of *hamus*, a  
hook.
- HA'STATE.**—See page 36.
- HERBA'CEUM.**—Latin. Herbaceous.
- HERBA'CEOUS.**—Herb-like; that per-  
ishes every year. An annual stem.  
Not woody.
- HELIA'NTHUS.**—See page 51.
- HERMA'PHRODITE.**—From the Greek,  
*ermes*, Mercury, and *aphrodite*,  
Venus. An organized body com-  
bining in reality or appearance the  
characteristics of both sexes.
- HEPTAGY'NIA.**—From the Greek,  
*hepta*, seven, and *gune*, pistil.  
Name of an order of plants. See  
page 103.
- HEPTAN'DRIA.**—From the Greek,  
*hepta*, seven, and *aner*, stamen.  
Name of a class of plants.
- HESPERI'DE or HESPERI'DIUM.**—A  
form of fruit.

- HEPTAGY'NIA.**—From the Greek, *exa*, six, and *gune*, pistil. Name of an order of plants.
- HEXA'NDRIA.**—From the Greek *exa*, six, and *aner*, stamen. Name of a class of plants.
- HIBER'NATE.**—From the Latin, *hibernare*, to winter. Animals that retire and sleep throughout the winter are said to hibernate.
- HI'LUM.**—Latin. The little black spot on a bean.
- HIRSU'TUS.**—Latin. Hairy.
- HOMOGE'NEOUS.**—See page 23.
- HOR'DEUM.**—Latin. Barley.
- HU'MULUS.**—Latin. Hops.
- HYDROCYA'NIC.**—From the Greek, *odor*, water, and *kuanos*, blue. The name of an intensely poisonous and peculiar acid.
- HYME'NIUM.**—From the Greek, *umen*, a membrane.
- HYPOCRATE'RIFORM.**—From the Greek, *upo*, under, *krater*, cup, and *phorme*, shape. Salver-shaped.
- HYPOGY'NOUS.**—From the Greek, *upo*, under, and *gune*, pistil. Arising beneath the ovary.
- HYPOPETA'LEÆ.**—From the Greek, *upo*, beneath, and *petalon*, petal. Name of a class of plants.
- HYPOPE'TALOUS.**—Relating to hypopetalæ.
- HYOSCIA'MUS.**—From the Greek, *us*, a swine, and *kuamos*, a bean. Henbane.
- IDÆ'US.**—Latin. Belonging or relating to Mount Ida.
- IM'BRICATE.**—Tiled. When the scales of a stalk or calyx lie over one another in the manner of tiles or shingles on a house.
- INCI'SA.**—Latin. Cut, carved, cut off.
- IN'DICA.**—Latin. Indian.
- INDI'GENOUS.**—Native to a country.
- INDEHI'SCENT.**—See DEHISCENT.
- INFLORE'SCENCE.**—The flowering of plants.
- INFO'LDLED.**—Folded in.
- INFUNDI'BULAR.**—From the Latin, *infundibulum*, a funnel. Funnel-shaped.
- INTE'GUMENT.**—From the Latin, *tegere*, to cover. The covering, the skin.
- INTERCE'LLULAR.**—From the Latin, *inter*, between, and *cellulæ*, little cells. Placed between cells.
- INVOLU'CRE.**—An accessory envelope of a flower, formed of bracts.
- INVOLU'CRUM.**—Latin. Involucre.
- IRI'DEÆ.**—Systematic name of a family of plants of which the Iris is the type.
- I'SOLATED.**—Separated; alone.
- JASMI'NEÆ.**—Systematic name of a family of plants of which the jasmine is the type.
- LABIA'TÆ.**—Systematic name of a family of plants known by having a labiate or two-lipped corolla (page 125).
- LABIA'TÆ.**—From the Latin, *labium*, lip. Having lips.
- LABU'RNUM.**—Latin. Name of a plant.
- LACI'NIATE.**—See page 35.
- LACU'NA.**—Latin. A pit, a hollow, a vacancy.
- LACU'NÆ.**—Latin. Plural of lacuna.
- LA'MINA.**—Latin. A thin plate.
- LA'MINÆ.**—Latin. Plural of lamina.
- LA'NCEOLATE.**—See page 43.
- LA'TEX.**—Latin. A peculiar fluid, which is usually turbid, and of a red, white, or yellow colour.
- LAURI'NEÆ.**—From the Latin, *laurus*, a laurel or bay tree. Name of a family of plants.
- LEGU'ME.**—From the Latin, *legu'men*, all kinds of beans, peas, &c. A form of fruit.
- LEGUMINO'SÆ.**—Systematic name of a family of plants.
- LENTI'CULAR.**—Shaped like a lens.
- LIBER.**—Latin. Bark.
- LIG'NEOUS.**—Woody.
- LIG'NIN.**—Solid matter found in the elongated cells of wood.
- LILIA'CEÆ.**—Name of a family of plants.
- LIME.**—The spreading part or border of a leaf or petal.
- LI'NEAR.**—See page 34.
- LINIARIFO'LIOUS.**—See page 34.
- LI'NUM.**—Latin. Flax.
- LOBED.**—Composed of lobes.
- LO'LIUM.**—Latin. Darnel.
- LOME'NTUM.**—A form of fruit.
- LU'PULUS.**—Latin. Little hops.
- LYCOPODIA'CEÆ.**—From Lycopodium, formed from the Greek, *lukos*, wolf,



**MONODE'LPHOUS.** — Relating to one brotherhood.

**NU'TRITIVE.**—Affording nourishment.

- OS.—*See page 35.*
- OB'CORDATE.—*See page 35.*
- OBO'VATE.—*See page 42.*
- O'CHREÆ.—Latin. Boot. *See page 34.*
- OCTA'GONAL.—From the Greek, *octô*, eight, and *gonia*, angle. Relating to an octagon, a figure contained in eight sides, and having eight angles.
- OCTAGY'NIA.—From the Greek, *octô*, eight, and *gune*, pistil. Name of an order of plants.
- OCTA'NDRIA.—From the Greek, *octô*, eight, and *aner*, stamen. Name of a class of plants.
- O'LEA.—Latin. An olive tree.
- OLEA'GINOUS.—From the Latin, *oleum*, oil. Oily; unctuous.
- OP'POSITE.—Standing against each other on opposite sides of the stem.
- O'RANGERY.—A kind of gallery, for the preservation of orange trees, during the winter.
- ORBI'CLATE.—*See page 42.*
- O'RGAN.—From the Greek, *organon*, an instrument. Part of an organized being, destined to exercise some particular function; for example, the ears are the organs of hearing, the muscles are the organs of motion, &c.
- ORGA'NIC.—Relating to an organ.
- ORGANIZA'TION.—A mode of structure.
- O'RNUS.—Latin. A wild ash.
- ORY'ZA.—Latin. Rice.
- O'VARY.—From the Latin, *ovum*, an egg. A hollow case, enclosing the ovules or young seeds, which ultimately become fruit.
- OVA'RIAN.—Relating to the ovary.
- O'VOID.—Egg-shaped.
- O'VULE.—A young seed.
- PA'CHYDERM.—From the Greek, *pachus*, thick, and *derma*, skin. Name of an order of animals.
- PA'LEA.—Latin. Chaff.
- PA'LEÆ.—Plural of *palea*.
- PALMA'CEÆ.—Name of a family of plants.
- PA'LMATE.—*See page 42.*
- PALMA'TO-LOBATE.—*See page 36.*
- PALMINE'RVE.—*See question, page 31.*
- PA'NICLE.—A loose irregular bunch of flowers with subdivided branches.
- PANDU'RATE.—*See page 39.*
- PANDU'RIFORM.—Same as *pandurate*.
- PAPA'VER.—Latin. Poppy.
- PAPAVERA'CEÆ.—Name of a family of plants.
- PAPILIONA'CEÆ.—From the Latin, *papilio*, a butterfly. Name of a family of plants whose flowers are supposed to resemble a butterfly.
- PAPILIONA'CEOUS.—*See page 75.*
- PAPYRIFE'RA.—From the Latin, *papyrus*, a kind of paper, and *fero*, I bear. Specific name of a plant.
- PA'RASITE.—A hanger-on; an adherent.
- PARE'NCHYMA.—*See page 29.*
- PARENCHY'MATOUS.—*See note, page 29.*
- PARI'ETES.—From the Latin, *pari'es*, a wall. The sides or parts forming an enclosure: the limits of different organic cavities are so termed.
- PARTI'TE.—Deeply divided. *See page 43.*
- PE'DATE.—*See page 47.*
- PEDA'LINERVE.—*See page 31.*
- PE'DICLE.—A little foot or support.
- PE'DICEL.—One of the ramifications of that part of the flower called peduncle.
- PEDI'CELLATE.—Having pedicles.
- PEDU'NCLE.—The foot-stalk, or support of a flower.
- PEDU'NCULATE.—Growing on peduncles or foot-stalks.
- PELTA'TE.—*See page 40.*
- PE'LTI'NERVE.—*See question, page 31.*
- PE'NNINERVE.—*See question, page 31.*
- PENTAGY'NIA.—From the Greek, *pente*, five, and *gune*, pistil. Name of an order of plants.
- PENTA'NDRIA.—From the Greek, *pente*, five, and *aner*, stamen. Name of a class of plants.
- PENTA'NDROUS.—Having five stamens.
- PE'PO.—A form of fruit.
- PERE'NNIAL.—From the Latin, *per*, through, and *annus*, year. Those plants whose roots remain alive more years than two, but whose stems flower and perish annually, are termed perennial.
- PERFO'LIATE.—*See page 39.*
- PE'RIANTH.—From the Greek, *peri*, around, and *anthos*, flower. The tegumentary parts of a flower.

**PERICARP.**—From the Greek, *peri*, around, and *carpos*, fruit. Parts surrounding the seeds.

**PERIGON.**  
**PERIGONIUM.** { From the Greek, *peri*, around, and *geinomaï*, I grow. A floral envelope, which partakes of the nature both of calyx and corolla.

**PERIGYNOUS.**—From the Greek, *peri*, around, and *gune*, pistil. Surrounding the pistil.

**PERISPERM.**—From the Greek, *peri*, around, and *sperma*, seed. Another name for the albumen.

**PERISTAMINEÆ.**—Name of a class of plants.

**PERSICA.**—Latin. Persian.

**PERSISTENT.**—Permanent. Not falling.

**PERSONATE.**—From the Latin, *persona*, a mask. A form of corolla.

**PERTUSSUM.**—Latin. Broken, cracked.

**PETAL.**—From the Greek, *petalon*, leaf. A part of the corolla, analogous to a leaf.

**PETIOLE.**—That portion of a leaf which connects the limb or lamina of a leaf with the stem; the foot-stalk.

**PHANEROGAMOUS.**—From the Greek, *phaneros*, evident, and *gamos*, marriage. Applied to plants having distinct flowers.

**PHYSIOLOGY.**—From the Greek, *phusis*, nature, and *logos*, a discourse. The science which treats of the functions of animals or vegetables.

**PHYTIVOROUS.**—From the Greek, *phuton*, plant, and *voro*, I eat. Plant-eating.

**PILI.**—Latin. Plural of *pilus*, hair.

**PILEUS.**—Latin. A cap, helmet.

**PILOSITY.**—Hairyness.

**PILUS.**—Latin. Hairy.

**PINNATE.**—See page 42.

**PISUM.**—Latin. A pea.

**PISTIL.**—From the Latin, *pistillum*, a pestle.

**PLACENTA.**—Latin. A cake.

**PLANTULE.**—A diminutive plant.

**PLIATE.**—From the Latin, *plicatus*, plaited. Folded like a fan.

**PLUMULE.**—From the Latin, *plumula*,

a little feather. A young diminutive stem.

**PODOSPERM.**—From the Greek, *pous*, foot, and *sperma*, seed. The seed-stalk, or little stem which attaches the seed to the placenta.

**POLLIN.**—The fertilizing powder of plants.

**POME.**—An apple; a form of fruit.

**POLYADELPHIA.**—From the Greek, *polus*, many, and *delphos*, brotherhood. Name of a Linnean class.

**POLYANDRIA.**—From the Greek, *polus*, many, and *aner*, stamen. Name of an order of plants.

**POLYANTHOCA'RPOUS.**—From the Greek, *polus*, many, *anthos*, flower, and *karpos*, fruit. Applied to a form of fruit formed of many flowers.

**POLYGAMIA.**—From the Greek, *polus*, many, and *gamos*, marriage. Name of a Linnean class.

**POLYGAMOUS.**—Same derivation. Relating to polygamia.

**POLYGON.**—See page 11.

**POLYGONAL.**—Relating to a polygon.

**POLYGYNIA.**—From the Greek, *polus*, many, and *gune*, pistil. Name of an order of plants.

**POLYHEDRAL.**—From the Greek, *polus*, many, and *edra*, seat. Relating to a polyhedron, a geometrical figure, bounded by many faces or planes.

**POLYPETALÆÆ.**—From the Greek, *polus*, many, and *petalon*, a petal. Name of a class of plants.

**POLYPETALOUS.**—Same derivation. Having many petals.

**POLYSEPALOUS.**—Having many sepals.

**PRIMULACEÆ.**—From *primula*, a primrose. Name of a family of plants.

**PRUNUS.**—Latin. A plum tree.

**PUBESCENCE.**—From the Latin, *pubescens*. Downy.

**PUDICA.**—Latin. Modest.

**PUMILA.**—Latin. Dwarfish, little.

**PURGENT (leaf).**—See page 35.

**PYRUS.**—Latin. A pear tree.

**QUADRUMANA.**—From the Latin, *quadrinus*, formed from *quatuor*, four, and *manus*, hand. Having four hands.



- QUATE'RNATE.—See page 44.
- QUATE'RNARY.—From the Latin, *quaternarius*, the number four. Relating to four.
- QUATRE'NNIAL.—Every fourth year.
- QUE'RCUS.—Latin. An oak tree.
- QUINA'RY.—Relating to five.
- QUINA'TE.—See page 45.
- QUI'NQUEFID.—Five cleft.
- QUINQUEFO'LIATE.—See page 45.
- RACE'ME.—From the Latin, *racemus*, a bunch, a cluster.
- RA'CHIS (ra'kis).—From the Greek, *rachis*, the spine, a branch, which proceeds in nearly a straight line from the base to the apex of the inflorescence of a plant.
- RA'DIATE.—From the Latin, *radius*, a spoke of a wheel. Rayed; diverging in rays.
- RA'DICLE.—A little root.
- RA'DIX.—Latin. A root.
- RAM'USCULE.—From the Latin, *ramus*, a branch, a small or diminutive branch.
- RAMIFICA'TION.—Branching, a branch.
- RECE'PTACLE.—A dilated portion of the peduncle, containing nutritive matter.
- RE'NIFORM.—See page 40.
- RE'PANDATE.—See page 38.
- RE'PENT.—Creeping.
- RESIDA'CEÆ.—From *Resida*, one of the genera. Name of a family of plants.
- RE'SIN.—Vegetable substance, distinguishable by its solubility in alcohol, and insolubility in water.
- RE'SINOUS.—Of the nature of resin.
- RESPIRA'TION.—From the Latin, *respiro*, I take breath. The act of breathing. A function proper to animals as well as plants.
- RESPI'RATORY.—Belonging to the function of respiration.
- RETI'CLAR.—See question, page 13.
- RHI'ZOME.—See page 18.
- RHO'MBOID.—See page 41.
- RO'BUR.—Latin. An oak; strength.
- ROSA'CEÆ.—Name of a family of plants.
- ROSSO'LIS.—French name of the Sundew, or *Drosera*.
- RO'TATE.—Wheel-shaped.
- RU'BUS.—Latin. A blackberry bush.
- RUBIA'CEÆ.—Name of a family of plants.
- RU'GOSE.—Rough or wrinkled.
- SACCHA'RUM.—Latin. Sugar.
- SACCHARI'NE.—Sugary; relating to sugar.
- SA'GITATTE.—See page 36.
- SA'ROCOCARP.—From the Greek, *sarx*, flesh, and *karpos*, fruit. The pulp or flesh of the fruit.
- SA'TIVUS-A-UM.—Latin. That which may be planted or sown.
- SCAPE.—A kind of stem. See page 21.
- SCOPA'RUM.—From the Latin, *scopa*, butcher's broom, milfoil. Specific name of a plant.
- SCURF.—See page 15.
- SCU'TUM.—Latin. A shield.
- SECA'LE (seca'ley).—Latin. Rye.
- SECRE'TION.—See page 56.
- SEED.—See page 66.
- SE'GMENT.—A section; a part cut off.
- SEGREGA'TA.—From the Latin, *segregatus*, separated. Name of an order of plants.
- SE'MINULES.—Diminutive seeds.
- SEMPER'VIRENS.—See pages 23 and 34.
- SE'PAL.—See page 70.
- SE'RRATE.—See pages 38 and 41.
- SE'SSILE.—See page 66.
- SE'TA.—Latin. A bristle.
- SE'TÆ.—Plural of seta.
- SETA'CEO-ACU'MINATE.—See page 35.
- SETO'SUS.—Latin. Bristly.
- SHOOTS.—See page 63.
- SIL'LIQUA.—Latin. A pod.
- SILICULO'SA.—Diminutive of siliqua.
- SINA'PIS.—Latin. Mustard.
- SIN'UATE.—See page 37.
- SINUOSE.—See page 37.
- SIN'US.—Latin. A bay. See page 37.
- SOLA'NEÆ.—From *Solanum*. Name of a family of plants.
- SOLA'NUM.—Latin. Nightshade.
- SOMNI'FERUM.—Latin, formed from *somnus*, sleep, and *fero*, I bear. Sleep-inducing. Specific name of a poppy.
- SO'ROSE.—From the Greek, *sôros*, a heap. A form of fruit.
- SPA'DIX.—A form of inflorescence in which the flowers are arranged around a fleshy rachis, and en-

- closed within a kind of bract, called a spathe, as in palms.
- SPARSE.**—From the Latin, *sparsus*, scattered.
- SPA'RTIUM.**—Latin. Broom.
- SPA'THE.**—Greek, a ladle. A form of involucre.
- SPA'TULATE.**—See p. 40.
- SPE'RMODERM.**—From the Greek, *sperma*, seed, and *derma*, skin. Seed-covering.
- SPIKE.**—An assemblage of axillary flowers arranged on a simple axis.
- SPIKE'LET.**—A little spike.
- SPINO'SA.**—Latin. Thorny.
- SPONGI'OLE.**—See p. 19.
- SPORE.**—Seed of Lichens.
- SPORI'FEROUS.**—From *spora*, and *fero*, I bear. Bearing spores.
- SPO'RULE.**—Diminutive spores.
- STA'MEN.**—Latin. Male apparatus of a flower.
- STEM'MULE.**—A little stem.
- STELLA'TE.**—From the Latin, *stella*, a star. Star-shaped.
- STI'GMA.**—The superior terminating part of the pistil.
- STIGMA'TA.**—Plural of stigma.
- STI'MULANS.**—Latin. Pricking, irritating.
- STI'MULI.**—Latin, plural of stimulus. Stings.
- STIPE.**—See p. 22.
- STI'PULE.**—See p. 33.
- STO'MATA.**—See p. 14.
- STYLE.**—That part of the pistil between the stigma and ovary.
- SUB'ULATE.**—Awl-shaped.—See p. 34.
- SUC'CULENT.**—Juicy.
- SUPE'RFLUA.**—Latin. Superfluous.
- SUPER-O'VARY.**—Applied to flowers which have the perianth and stamens above the ovary.
- SUPERPO'SED.**—From the Latin, *super*, upon, and *pono*, I place. One lying upon or placed on another.
- SU'TURE.**—From the Latin, *suo*, I stitch. A seam or line of junction.
- SY'CON.**—From the Greek, *sukon*, a fig. A form of fruit.
- SYNANTHE'REÆ.**—From the Greek, *sun*, with, and *anthos*, flower. Name of a family of plants.
- SYNCA'RPOUS.**—From the Greek, *sun*, with, and *karpos*, fruit. Applied to fruits formed of several carpels.
- SYNGENE'SIA.**—From the Greek, *sun*, together, and *geinomai*, to grow. Name of a Linnæan class.
- TABAC'CUM.**—Latin. Tobacco.
- TEGUME'NTARY.**—From the Latin, *tegere*, to cover. Belonging or relating to covering.
- TEN'DRIL.**—See p. 34.
- TER'MINAL.**—Applied to flowers at the extremity of the stem.
- TER'NARY.**—Relating to three.
- TER'NATE.**—See p. 44.
- TETRADY'NAMOUS.**—From the Greek, *tetteres*, four, *dunamis*, power. Applied to plants having four long and two short stamens.
- TETRADYNA'MIA.**—Name of a Linnæan class.
- TETRAGY'NIA.**—From the Greek, *tetteres*, four, and *gune*, pistil. Name of an order of plants.
- TETRA'NDRIA.**—From the Greek, *tetteres*, four, and *aner*, stamen. Name of a class of plants.
- TETRA'NDROUS.**—Relating to tetrandria.
- THA'LLUS.**—A flat membrane belonging to cellular plants.
- THYRSUS.**—A kind of cluster.
- TI'SSUE.**—From the Latin, *texere*, to weave. The interlacement or union of many things which form a body, as threads of flax, silk, wool, &c., of which cloths and stuffs are made. From analogy the term is employed to describe the *substances* of which the organs of plants and animals are composed.
- TOLA'MEN.**—A border.
- TO'RUS.**—Terminal portion of the pedicel.
- TRA'CHEA (trak-ea).**—(In the plural, tracheæ). Tubes or vessels in the structure of plants which are supposed to convey air.
- TRIA'NDRIA.**—From the Greek, *treis*, three, and *aner*, stamen. Name of a class of plants.
- TRIA'NDROUS.**—Having three stamens.
- TRICO'LORED.**—Latin. Three-coloured.
- TRIE'NNIAL.**—Every three years.

- TRI'FID. — Three-cleft: divided in three.
- TRIGY'NIA. — From the Greek, *treis*, three, and *gune*, pistil. Name of an order of plants.
- TRI'LOBATE. — See p. 37.
- TRICE'CIA. — From the Greek, *treis*, three, and *oikos*, house. Name of a Linnean class.
- TRIBE'TALOUS. — From the Greek, *treis*, three, and *petalon*, petal. Having three petals.
- TRIPIN'NATE. — See p. 47.
- TRITE'RNATE. — See p. 44.
- TRI'TICUM. — Latin. Wheat.
- TRO'PHOSPERM. — From the Greek, *trepho*, I nourish, and *sperma*, seed. That part of the carpel from which the seeds spring.
- TU'BER. — Latin. A bunch, a knot, a lump. A form of root.
- TU'BERCLE. — A small knot or projection.
- TUBERO'SUM. — Latin, tuberous. Of the nature of a tuber.
- TU'BIFORM. — Tube-shaped.
- TU'BULAR. — Consisting of tubes or pipes: relating to a tube.
- UM'BEL. — A form of inflorescence in which several peduncles expand so as to produce a flower somewhat resembling a parasol when open.
- UMBELLI'FERÆ. — From *umbel*, and *fero*, I bear. Name of a family of plants.
- UMBELLI'FEROUS. — Belonging to Umbelliferæ.
- UN'CI. — Latin. Plural of *uncus*. Hooks.
- UN'DULATE. — See p. 39.
- UNGUI'ULATE. — From the Latin, *unguis*, a claw. Having a claw.
- UNILO'ULAR. — From the Latin, *unus*, one, and *loculus*, partition: single-celled.
- UNISE'XUAL. — Of one sex.
- URCE'OLATE. — From the Latin, *urceus*, a pitcher: pitcher-shaped.
- URTI'CEÆ. — From the Latin, *urtica*, a nettle. Name of a family of plants.
- USITATI'SSIMUM. — Latin. Most common, familiar.
- UTRI'CULA. — From the Latin, *utriculus*, a little bottle. See p. 11, figs. 2 and 3.
- UTRI'CLAR. — Of or relating to *utricula*.
- VA'GINATE. — See p. 34.
- VALVE. — From the Latin, *valvæ*, doors. A little door.
- VA'SCULAR. — Supplied with vessels.
- VEGETA'TIVE. — Belonging or relating to vegetation.
- VELUTI'NUS. — Latin. Velvety.
- VE'NTRAL. — Relating to the belly.
- VE'RA. — Latin. True.
- VERNA'TION. — Applied to leaves in the state of buds.
- VERTICE'LLUS. — Latin. A whorl.
- VERTI'CILLATE. — Arranged in a whorl.
- VE'SCA. — Latin. Edible; any thing that may be eaten.
- VE'SICLE. — A small bladder.
- VESI'CLULAR. — Composed of vesicles.
- VEXI'LLUM. — Latin. A standard.
- VILLO'SITY. — Velvet-like; a covering of soft hairs, forming a nap like velvet.
- VILLO'SUS. — Latin. Velvety.
- VINI'FERA. — From the Latin, *vinum*, wine, and *fero*, I bear. Wine-bearing.
- VINI'FERÆ. — Name of a family of plants.
- VIOLA'CEÆ. — Name of a family of plants.
- VI'RENS. — Latin. Flourishing, green.
- VI'RIDIS. — Latin. Green.
- VI'TES. — Latin. Plural of *vitis*.
- VI'TIS. — Latin. A vine.
- VO'LUBLE. — Twining.
- VO'LVA. — Latin. A wrapper.
- ZE'A. — From the Greek, *zēō*, I live. Generic name of Indian corn or maize.











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